ANNUAL REPORT

OF THE

SECRETARY OF WAR

FOR

THE YEAR 1892.

IN FOUR VOLUMES.

VOLUME II—IN FOUR PARTS AND ATLAS.
PART 2.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.

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IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND, AND OF JAMES RIVER, VIRGINIA.

REPORT OF COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Patapsco River and Channel to Baltimore, Maryland.
2. James River, Virginia.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 9, 1892.

GENERAL: I have the honor to forward herewith the annual reports for the year ending June 30, 1892, for the works of improvement of rivers and harbors which have been in my charge.

In cases where the commercial statistics may not be as full and complete as desirable, it is not for want of desire and effort on my part to have them so.

During the year I have been Division Engineer of the Southeast Division, member of the Light-House Board until May 19, 1892, and of a number of special Boards.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

I 1.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND.

The act of August 11, 1888, appropriated $300,000, with which the improvement was vigorously continued under contract until the end of August, 1889, when operations were brought to a close for want of

funds. The depth of the channel was already 27 feet at low water, by which access was afforded to Baltimore by ships of the heaviest tonnage. With this appropriation great improvement in the width of the channel had been made, especially at the angles.

The next appropriation was of $340,000, September 19, 1890, and another of $151,200, March 3, 1891. The former contained the following clause:

Provided, That such contracts as may be desirable may be entered into by the Secretary of War for the completion of the existing project, or any part of same, to be paid for as appropriations may from time to time be made by law.

By advertisement of September 30, 1890, proposals were invited for completing the channel to a width of 600 feet, with a depth of 27 feet at mean low water, which were received December 2. The contract was awarded to the American Dredging Company, of Philadelphia, at 10½ cents per cubic yard for removal and redeposit, to cover 6,000,000 cubic yards of material. The time for completion of the work is June 1, 1893.

Under this contract operations were resumed as soon as the weather would permit, February 17, 1891.

There have been excavated during the fiscal year the following amounts of material:

	Cubic yards.
From lower division	771,953
From cut-off division	1,345,899
From Brewerton division	365,057
From Fort McHenry division	1,023,534
Total amount removed during fiscal year	3,506,443
Redeposited below Rock Point	937,622
Redeposited eastward of Craighill Channel	2,568,821
Total removed under existing contract	4,840,443

FORT M'HENRY DIVISION.

The areas excavated in this division during the fiscal year were: At lower end on west side, 4,000 by 250 feet; at upper end, 16,500 by 215 feet on the west side and 14,500 by 86 feet on the east side of channel.

BREWERTON DIVISION.

The area excavated in this division was 16,900 feet by 50 feet on north side and 4,000 by 50 feet on the south side.

CUT-OFF DIVISION.

On this division the areas excavated were: On the east side, 19,500 feet by 33⅓ feet, 5,100 by 66⅔ feet, 8,600 by 100 feet; and on the west side, 13,600 feet by 100 feet and 7,600 feet by 33⅓ feet.

LOWER DIVISION.

On the east side there was excavated during the year an area of 19,500 feet by 150 feet and on the west side an area of 52,400 feet by 50 feet, much of the latter being removal of deposits within the limits of the 400-foot channel.

All excavations mentioned are to a depth of 27 feet at mean low water.

LENGTH AND WIDTH OF THE SEVERAL DIVISIONS.

The Fort McHenry division, extending from the city limits of Baltimore to the upper end of the Brewerton division, is 28,500 feet long, with a minimum width of 400 feet.

Brewerton division.—This division extends from the lower end of the Fort McHenry division to the upper end of the cut-off division; it is 23,500 feet in length and 600 feet in width, being completed practically, though some work, small in extent, may be found necessary on a final examination.

Cut-off division.—This division is 23,100 feet in length with a minimum width of 533⅓ feet. It extends from the Brewerton to the lower division.

Lower division.—This extends from the cut-off division to deep water of the Chesapeake Bay; it is 24,000 feet long and 600 feet wide; present operations being confined to the removal of deposits from within the lines of the 400-foot channel as heretofore excavated.

Angles.—At the junctions of the several divisions the angles are all excavated to a maximum width of 1,000 feet for a depth of 27 feet at mean low water.

Surveys of the areas for dumping east of the lower division, and of the Brewerton and Fort McHenry divisions, were executed during the year, and revised estimates of the amount of excavation necessary to complete the project were made, based upon these surveys. The results show an increase of only 5 per cent on the original estimates, or 300,000 cubic yards, making the total quantity to be removed 6,300,000 cubic yards, which insures the practical completion of the project within the estimates.

Considerable repairs have been made to the hull and boiler of the tug *Leslie*. She is nearly 40 years old, but her condition is now quite good.

The following are the amounts and dates of appropriations for improving harbor at Baltimore, Md., including Patapsco River.

August 30, 1852	$20,000	June 18, 1878	$75,000
August 16, 1856	100,000	March 3, 1879	160,000
June 23, 1866	5,200	June 14, 1880	100,000
March 2, 1867	75,000	March 3, 1881	150,000
July 25, 1868	17,000	August 2, 1882	450,000
April 10, 1869	26,730	July 5, 1884	250,000
July 11, 1870	42,900	August 5, 1886	150,000
March 3, 1871	50,000	August 11, 1888	300,000
June 10, 1872	100,000	September 19, 1890	340,000
March 3, 1873	200,000	March 3, 1891	151,200
March 3, 1875	75,000		
August 14, 1876	75,000	Total	2,913,030

Money statement.

July 1, 1891, balance unexpended		$437,816.68
June 30, 1892, amount expended during fiscal year		371,506.53
July 1, 1892, balance unexpended		66,310.15
July 1, 1892, outstanding liabilities	$1,500.00	
July 1, 1892, amount covered by uncompleted contracts	205,834.03	
		207,334.03
Amount appropriated by act approved August 5, 1892		208,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894, for maintenance of completed channel		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS—STATEMENT OF THE COLLECTOR OF CUSTOMS OF BALTIMORE.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, July 28, 1892.

SIR: In accordance with the prevailing practice existing at this port requiring the collector to render annually a statement of the business transactions of the port of Baltimore, for information and use in your department, I have the honor to submit the following tabulated commercial statement for the fiscal year ending June 30, 1892, as compared with the twelve months preceding, ending June 30, 1891:

Tonnage movement.

	Foreign.			Coastwise.		
	1890-'91.	1891-'92.	Increase.	1890-'91.	1891-'92.	Decrease.
	Tons.	*Tons.*	*Per cent.*	*Tons.*	*Tons.*	*Per cent.*
Inward	706, 755	1, 123, 368	59	1, 382, 241	1, 192, 137	14
Outward	905, 215	1, 383, 935	53	1, 501, 158	1, 524, 602	*1½

* Increase.

Established steamship lines.

Name of steamship line.	No. of vessels.	Destination.
North German Lloyd	6	Bremen.
Allan Line	4	Liverpool.
Johnson Line	7	Liverpool.
Atantic Transport Line	6	London.
Donaldson Line	5	Glasgow.
Lord Line	5	Belfast and Dublin.
Buckman Line*	3	Port Antonio, British West Indies.
Neptune Line	7	Rotterdam.
Bristol Line	(†)	Bristol.
Empire Line	(†)	Leith.
Puritan Line	4	Antwerp.
Hamburg-American Line	7	Hamburg.
Sloaman Line	3	Brazilian ports.
Royal Netherlands Line	4	Rotterdam and Amsterdam.
Earn Line	5	Santiago de Cuba.
Liverpool, Brazil and River Platte*	4	Brazilian ports.
Blue Cross Line	7	Rotterdam and Havre.

* Two new lines established in 1892.
† Occasional.

Value of imports.

1892 (free)	$6, 652, 028
1891 (free)	9, 072, 802
Decrease in 1892	2, 420, 774
1892 (duitable)	6, 766, 225
1891 (dutiable)	11, 482, 885
Decrease in 1892	4, 716, 660

Recapitulation of imports.

1892 (free)	6, 652, 028
1892 (dutiable)	6, 766, 225
Total value 1892	13, 418, 253
Total value 1891	20, 555, 687
Decrease in 1892	7, 137, 434

Imports in American vessels, 1892:	
Sailing	$3,794,108
Imports in foreign vessels, 1892:	
Sailing	203,985
Steam	9,417,905
Imports in cars overland, 1892	2,255
Total, 1892	13,418,253

Value of domestic exports.

1892	98,796,856
1891	64,349,787
Increase in 1892	34,447,069
Exports in American vessels, 1892:	
Sailing	1,514,248
Exports in foreign vessels, 1892:	
Sailing	282,042
Steam	97,000,566
Total exports for 1892	98,796.846

Recapitulation of exports, 1892.

In American vessels	1,514,248
In foreign vessels	97,282,608
Total, 1892	98,796,846

Certain articles exported.

Articles.	Tons.	Articles.	Tons.
Cattle	31,650	Beef, canned	12,544
Corn	461,220	Beef, fresh	2,687
Wheat	581,041	Beef, salt	2,919
Flour	984,962	Tallow	12,430
Coal	92,385	Bacon	8,805
Copper matte	19,989	Hams	1,617
Copper ingots	5,270	Pickled pork	4,108
Cotton	61,425	Lard	30,146
Dried apples	1,731	Olio oil	3,405
Grape sugar	1,325	Cotton-seed oil	719
Rosin	13,918	Starch	3,231
Oil cake	30,939	Leaf tobacco	24,958
Illuminating oil	4,732	Tobacco stems	3,675
Wax	1,241	Zinc	1,070

Transportation in bond, with appraisement.

Destination.	Value.	Duty.	Destination.	Value.	Duty.
Alexandria, Va	$291	$103.41	New York, N. Y	11,827	10,002.98
Boston	300	105.00	Pittsburg, Pa	323	80.00
Chicago, Ill	106	53.00	Richmond, Va	98	62.00
Cleveland, Ohio	28	9.20	St. Louis, Mo	2,624	863.60
Georgetown, D. C	1,551	650.00	Wheeling, W. Va	750	303.85
Kansas City, Mo	46	20.70			
Louisville, Ky	432	259.20	Total	18,741	13,827.04
Milwaukee, Wis	365	1,314.10			

Transportation in bond without appraisement.

Destination.	Value.	Duty.	Destination.	Value.	Duty.
Buffalo, N. Y	$2,227	$1,951.85	Milwaukee, Wis	$57,398	$38,079.77
Charleston, S. C	930	428.10	Memphis, Tenn	7,997	5,760.00
Chicago, Ill	878,170	710,268.45	New York, N. Y	4,449	1,450.35
Cincinnati, Ohio	246,310	219,197.50	Omaha, Nebr	3,173	4,868.26
Cleveland, Ohio	150,427	89,687.39	Philadelphia, Pa	11,588	8,857.00
Columbus, Ohio	15,505	7,885.14	Pittsburg, Pa	61,238	26,573.41
Denver, Colo	2,291	7,000.00	Richmond, Va	3,299	1,607.80
Detroit, Mich	8,392	5,246.99	Rochester, N. Y	2,514	1,588.44
Dubuque, Iowa	1,709	749.14	St. Louis, Mo	329,138	202,560.53
Evansville, Ind	7,118	4,256.25	St. Paul, Minn	4,819	10,000.00
Georgetown, D. C	16,197	9,686.78	Toledo, Ohio	11,870	9,015.91
Grand Rapids, Mich	1,469	771.85	Wilmington, Del	306	709.59
Indianapolis, Ind	158,225	101,981.69			
Kansas City	2,816	5,295.00	Total		1,785,425.45
Louisville, Ky	230,200	309,948.26			

Summary of merchandise in bond without appraisement.

Year.	Value.	Duties.
1892	$2,219,070	$1,785,425.45
1891	3,497,768	1,662,242.96
Decrease	1,278,698	
Increase		23,182.49

Number of immigrants and passengers arriving:

1892	57,223
1891	42,004
Increase in 1892	15,319
Amount of duties collected	$3,073,119.97
Miscellaneous customs receipts	105,438.47
Total receipts for 1892	3,178,558.44
Total receipts for 1891	3,766,922.22
Decrease in 1892	588,363.78

Duties on merchandise in bond:

1892	219,752.15
1891	127,027.03
Decrease in 1892	92,725.12

Summary of duties in 1892.

Duties, etc., collected	$3,178,558.44
Duties on merchandise in bond	219,752.15
Duties on merchandise in bond with and without appraisement	1,799,252.49
Total	5,197,563.08

Vessels built.

Year.	No.	Gross tonnage.	Net tonnage.
1892	30	3,013.43	1,986.33
1891	23	2,605.07	2,095.61

Increase in the number of vessels built, 7.

	Tons.
Vessels entered from foreign ports:	
American—	
Sailing	52,638
Steam	2,701
Foreign—	
Sailing	17,571
Steam	1,050,458
Total	1,123,368
Vessels cleared for foreign ports:	
American—	
Sailing	51,817
Steam	714
Foreign—	
Sailing	9,618
Steam	1,321,786
Total	1,383,935
Vessels entered	1,123,368
Vessels cleared	1,383,935
Total foreign, 1892	2,507,303
Total, 1891	1,611,970
Increase in 1892 (55 per cent)	895,333
Vessels entered coastwise, 1892	1,192,137
Vessels cleared coastwise, 1892	1,524,602
Total coastwise, 1892	2,716,739
Total coastwise, 1891	2,883,499
Decrease in 1892	166,760

RECAPITULATION.

Total foreign tonnage in and out, 1892	2,507,308
Total coastwise tonnage in and out, 1892	2,716,739
Total tonnage, 1892	5,224,042
Total tonnage, 1891	4,495,469
Increase in 1892	728,573

STATISTICAL RECAPITULATION.

Dutiable merchandise has decreased	$4,716,660.00
Free merchandise has decreased	$2,420,774.00
Domestic exports have increased	$34,447,069.00
Total tonnage, foreign and coastwise, have increased (tons)	728,573
Decrease in the duties collected	$588,363.78
Increase in duties on merchandise in bond	$92,725.12
Increase in merchandise in bond with and without appraisement	$121,226.48
Increase in the number of vessels built	7

The tonnage movement at this port for the fiscal year ending June 30, 1892, shows a most gratifying and encouraging increase, both as to the number of vessels arriving and departing and in the increased carrying capacity, the latter being entirely due to the widening and deepening of the channel approaches to our harbor, which now enables vessels drawing 27 and 28 feet of water to pass up and down with perfect ease and safety.

There are 17 established lines of ocean steamers trading from this port to foreign ports, representing 77 steamships, ranging in net tonnage from 18,000 to 6,000 tons burden.

Two new lines have been established within the past year, viz, to Jamaica and Brazil, and four new ships added to those heretofore established.

The president of the Association of Maryland Pilots informs me that the average draft of water of the vessels in the foreign trade is 14 feet for sailing and 21 feet for

steam; 34 steam vessels drawing 25 to 28 feet have passed through the channel during the past year.

The facilities for landing and transporting immigrants have been increased and are now unsurpassed.

The activity of our local shipbuilders' yards is worthy of note. Of the 30 vessels built during the year just ended 20 of them are propelled by steam.

They are now constructing 4 sail and 15 steam, including the 2 United States vessels *Detroit* and *Montgomery*.

The marine plant at Sparrow Point has sprung into prominence, and the Maryland Steel Company is now prepared to build vessels of any size; 2 large steamers for our bay trade and 3 steam tugs are constructing. In addition to this, a contract for an ocean steamer of some 3,000 tons burden has just been awarded to them.

The vessels in our coasting trade not required by law to enter and clear at the custom-house, and not included in the foreign tonnage tables, aggregate about 2,300,000 tons.

The foreign-tonnage movement shows an increase of 55 per cent.

There are 1,217 vessels owned and documented in this collection district, representing 107,420 net registered tons.

There is a decided decrease in the imports in the past year, most noticeably in tin plate, chloride of zinc, coffee, wool dress goods, bananas, spices, and sugars.

In the matter of exports a most desirable increase is shown to the extent of $34,000,000, notably in wheat, corn, flour, all of which have gained from 100 to 200 per cent. Rosin, dried apples, oil cake, beef, tallow, lard, pork, cotton-seed oil show a most decided increase, while there is a perceptible increase running through 80 per cent of the entire merchandise exported.

Respectfully submitted,

WM. M. MARINE,
Collector.

Col. WM. P. CRAIGHILL,
Corps of Engineers.

I 2.

IMPROVEMENT OF JAMES RIVER, VIRGINIA.

The improvement was regularly undertaken by the United States in 1870. A small sum had been previously expended and was of some advantage to navigation. The total expended by the United States to July 1, 1892, has been $1,302,408.19. In addition the city of Richmond has expended nearly $500,000, but in the last five years only about $50,000, and this near the wharves of the city.

When the improvement was undertaken by the Government navigation was obstructed by sunken vessels, by remains of military bridges, and by obstructions put in the river during the late war to prevent the national fleets from approaching too close to Richmond. There were also natural obstructions.

Rockett Reef and Richmond Bar had only 7 feet of water at mean low tide. From Warwick Bar (where the depth was 13 feet) to Richmond the channel was crooked and obstructed by dangerous rocks and ledges. The Dutch Gap Cut-off, which now saves 5½ miles of difficult navigation, was not then open.

The original project was to secure a depth of 18 feet at full tide, corresponding to 14.5 feet at low tide, to Richmond, with a channel width of 180 feet from Harrison Bar to Richmond docks, the excavation in rock to be 18½ feet at full tide. This plan was well advanced when Congress, by act approved July 5, 1884, adopted the project of 22 feet at mean low tide from Richmond to the sea. Operations during the past year have been conducted in accordance therewith. In carrying it out further a large amount of excavation will be in solid rock, and the cost will necessarily be great. The width to be given to the channel is 400 feet from the sea to City Point, 300 feet from City Point to Drewry Bluff, and 200 feet from thence to Richmond. The methods

employed for improving the river consist in dredging, rock excavation, and the contraction of the water way by means of dikes or jetties.

Mr. C. P. E. Burgwyn continued the resident engineer of the work until December 1, 1891, when he was succeeded by Mr. H. D. Whitcomb, who had been his predecessor for a number of years. The detailed report of Mr. Whitcomb is herewith.

The following are the amounts and dates of appropriations for improving James River, Virginia:

July 11, 1870	$50,000	June 14, 1880	$75,000
March 3, 1871	50,000	March 3, 1881	60,000
June 8, 1872	50,000	August 2, 1882	75,000
March 3, 1873	75,000	July 5, 1884	75,000
June 23, 1874	50,000	August 5, 1886	112,500
March 3, 1875	50,000	August 11, 1888	225,000
August 14, 1876	60,000	September 19, 1890	200,000
June 18, 1878	70,000		
March 3, 1879	75,000	Total	1,352,500

Money statement.

July 1, 1891, balance unexpended		$142,957.65
June 30, 1892, amount expended during fiscal year		98,902.63
July 1, 1892, balance unexpended		44,055.02
July 1, 1892, outstanding liabilities	$2,000.00	
July 1, 1892, amount covered by uncompleted contracts	33,087.44	
		35,087.44
July 1, 1892, balance available		8,967.58
Amount appropriated by act approved July 13, 1892		200,000.00
Amount available for fiscal year ending June 30, 1893		208,967.58
Amount (estimated) required for completion of existing project		3,536,070.45
Amount that can be profitably expended in fiscal year ending June 30, 1894		400,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for construction of a railroad track, transfer slip, car and caisson, improving James River, Virginia. Opened October 15, 1891, at 12:05 p. m.

No.	Name and residence of bidder.	A—1,000 feet of railroad track per linear foot.		B—Transfer slip.	C—Caisson.	D—Car.	Grand Total.
		Price.	Total.				
1	George Washington Donly, Richmond, Va				$2,700.00		
2	C. D. Langhorne, Richmond, Va *	$5.35	$5,350.00	$3,000.00			
3	W. B. Brooks, jr., Baltimore, Md.†	4.95	4,950.00	2,933.33	2,750.00	$750.00	$11,383.33
4	The Tredegar Company, Richmond, Va					325.00	
5	H. Brusstar & Bro., Baltimore, Md				2,896.00		
6	Henry M. Doremus, Newark, N. J	5.75	5,750.00	3,500.00	2,950.00	575.00	12,775.00
7	H. T. Morrison & Co., Petersburg, Va				2,476.17	491.34	

* Or will construct railroad track and slip at 10 per cent on cost of same.

† By telegram received at 11:17 a. m., makes his bid on railroad track $5.95 per linear foot, or a total of $5,950 for that item.

Available for contracts, $15,000.
Contract with No. 2 for items A and B.
Contract with No. 4 for item D.
Contract with No. 7 for item C.

REPORT OF MR. H. D. WHITCOMB, ASSISTANT ENGINEER.

ENGINEER OFFICE,
Richmond, Va., July 1, 1892.

COLONEL: I have the honor to submit the following report of operations connected with the improvement of James River for the fiscal year ending June 30, 1892.

I am indebted to the monthly reports of Mr. C. P. E. Burgwyn, my predecessor as assistant engineer; and to Mr. E. G. Higginbotham, inspector, as to operations previous to December, 1891.

SURVEYS AND TIDAL OBSERVATIONS.

A very complete survery was made in September, 1891, from the city limits to Goodes Rocks, which was continued to the head of Richmond Bar in January, 1892. Soundings were taken at intervals of 10 feet on lines 20 feet apart, and give detailed information as to the condition of the river bed in that distance.

A survey was made of Kingsland Reach previous to the last dredging done and another after it was completed, in May, 1892. Soundings were also taken in September, 1891, and in May, 1892, between the wing dams from the head of Richmond Bar to Drewry Bluff, and several lines of soundings at intervals of 10 feet on the site of the military obstructions of 1861-'65 at Drewry Bluff. Soundings were also taken in Dutch Gap before and after the recent dredging there. The positions of all these with those of some other minor surveys, except the first in Kingsland Reach, were measured between established points by a graduated wire, and on other surveys with the position of soundings determined by angles, as at Wards Reach, a cross over shoal between Drewry and Chaffin Bluffs.

Tidal observations were taken at ten-minutes intervals, day and night, during the month of August, 1891, at Warwick Bar, Dutch Gap, City Point, Sandy Point, Kings Mill Wharf, and Cape Charles, and at intervals of about 5 miles between Richmond and Newport News, for one tide, accompanied with observations on the currents.

These surveys and current observations were made under the personal direction of Mr. Higginbotham.

DREDGING AND OTHER WORK.

At the beginning of the fiscal year work was being prosecuted under a contract with Mr. C. D. Langhorne for excavation at several points between Richmond and the lower part of Kingsland Reach; and with Mr. W. Hampton Curtis for wing dams at Wilton.

CITY LIMITS TO GOODES ROCKS.

Mr. Langhorne completed his contract for dredging between the city limits and Stearns Dike in July, 1891, having excavated 6,673 cubic yards of disintegrated and 154.2 cubic yards of solid rock in this year, making a total of 30,724.8 cubic yards of disintegrated and 478 cubic yards of solid rock on this section.

He had completed his contract from Stearns Dike to Goodes Rocks in the previous fiscal year. Under the contract, the United States were to do any blasting necessary at rocky points above Goodes Rocks. The dredges were worked over the areas covered by the contract, making the full depth of 22 feet in many places, but quite a number of areas remain, too hard to be removed by the dredges employed. No drilling or blasting was done by the United States, as the total cubic yards specified in the contract had been removed.

A supplementary contract, modifying the former, was approved March 26, 1892, under which work was immediately resumed on the lower of these two sections, and later on the other. Under this 9,140.4 cubic yards of disintegrated and 48.1 cubic yards of bowlders classed as solid rock have been removed.

It seems probable that the disintegrated rock mentioned, a granite or gneiss, is softened to a limited depth in many places when exposed to the current, and that a dredge can often remove an additional foot or so of material after an exposure of a few months, which had been previously too hard. There is a limit to this process of softening in approaching the underlying solid rock, which rises to near the present bottom in many places.

The amount to be expended on these two sections by the supplementary contract is not to exceed $15,000, including the expense incurred by the United States in drilling and blasting. The intention of the contract is to open a channel above Richmond Bar at least 60 feet wide by 18 feet deep at low tide. The same contract

reduces the quantity of sand to be dredged below Richmond Bar from 102,600 to 25,000 cubic yards, and limits the expenditure at Goodes Rocks under it to $13,000.

GOODES ROCKS.

Operations from the former fiscal year were continued on the new channel until November 1, 1891, and included drilling and blasting by the contractor, as well as dredging.

Work was resumed in March, 1892, under the supplementary contract, and is still in progress, and until June 27, 1892, was confined to removing the débris from the blasting of 1891 and previous years. Drilling and blasting are now resumed, and about 370 cubic yards of bottoming remain to be removed before the full depth of 22 feet is attained in this new channel.

The contractor has also dredged 2,099.6 cubic yards of disintegrated rock and 147.3 cubic yards of solid rock (under the supplementary contract) in a channel connecting the cut last mentioned with that over Richmond Bar. All the rock taken from the new channel was placed on the wing dams and training walls, mainly at Wilton and Kingsland Reach.

GOODES ROCKS TO RANDOLPH FLATS.

The contractor worked from July 17 to October 31, 1891, in deepening the channels at the head of Richmond Bar and opposite the monitor fleet at Randolph Flats. Hard, disintegrated rock was found for a short distance at the head of Richmond Bar at depths of 16 feet and over. This cut was continued for only 900 feet, and was mainly in coarse gravel and cobble, containing some large bowlders. Ten thousand and sixty-nine and six-tenths cubic yards were removed, of which 722.8 cubic yards were in bowlders classed as solid rock.

The material in Randolph Flats was sand overlying coarse gravel and cobble, containing bowlders and small areas of disintegrated rock, at from 20 to 22 feet below low tide. The amount removed here was 31,601 cubic yards, of which 163.8 cubic yards were classed as solid rock. A further amount of 2,581.4 cubic yards of sand and gravel were dredged from the lower part of this shoal in March, 1892.

KINGSLAND REACH.

The contractor, Mr. C. D. Langhorne, began dredging a channel through this shoal in November, 1891, and completed his contract in February, 1892. He removed 45,050.8 cubic yards, including 132 cubic yards of bowlders classed as solid rock. This shoal is a cross-over where the river had a width of 1,000 feet, and has been one of the most annoying to navigation, especially after great freshets. The current is now confined between brush training walls 550 feet apart, and a channel 200 by 22 feet has been dredged between them. The core of the bar was of heavy gravel and cobble. It is expected that the contraction now made will maintain the channel. A levee on the right bank was estimated for in 1877, after the great freshet of that year, to prevent such a diversion of the current as then occurred, and may yet be found important. Two openings in the training walls, aggregating 430 feet, left for the deposition of dredged material behind them, should be closed, and it may be necessary to further strengthen the brush work with stone from excavations near the city. The remains of two sunken vessels which partly obstructed the new channel were removed by the United States in April, 1892.

DUTCH GAP.

A contract was made in February, 1892, with Mr. C. T. Caler for the removal of not exceeding 15,000 cubic yards from the slide of 1889 in Dutch Gap. The contract was finished May 4, 1892, by the removal of 13,545.4 cubic yards. The slide is now removed to a depth of 18 feet in the fairway, and to from 10 to 14 feet for the remainder. The surface width of the cut is now 515 feet at the upper entrance and 330 feet at the narrowest point, which is near the lower entrance. The 18 feet contours are 320 feet apart at the former and 190 feet at the latter with a channel depth of more than 20 feet in each case. There is a fairway entirely through the cut 100 feet wide by over 18 feet deep; but at the upper entrance there is a shoal area of 20,000 square feet, left in former dredging, with less than 18 feet depth, and in this an area of 800 square feet with less than 15 feet, one sounding being 13.7 at low tide. There are 18 feet or more on each side of this shoal area. The bottom of this cut is a very hard clay, dredged with difficulty unless loosened by explosives. Further reference to this cut and vicinity is made elsewhere.

WING DAMS AT WILTON.

These were completed in August, 1891, by Mr. W. Hampton Curtis, contractor. They are thoroughly well built and protected with stone. They are all on the left bank and their numbers and lengths are as follows:

	Feet.		Feet.
No. 114	53.8	No. 134	222.4
No. 116	86.5	No. 138	176.3
No. 118	143.2	No. 142	182.8
No. 120	195.8	No. 146	225.0
No. 124	246.5	No. 150	205.3
No. 128	264.6		
No. 132	254.8	Total length	2,257.0

TRANSFER SLIP, ETC.

This work was designed to facilitate the distribution behind the dikes of material dredged between Richmond Bar and Falling Creek, a distance of nearly 4 miles, where the river bed is of sand mainly.

It consists of a railway of standard gauge about 1,300 feet long and 8 feet above high tide, built on a pile causeway, with an incline to the river, on a grade of about 2 per cent, where it will connect with a barge rising and falling with the tide. To this scows with loaded cars can be brought and thence taken by a locomotive to the dumping ground.

The railway was built, under a contract with Mr. C. D. Langhorne, between November, 1891, and April, 1892. All the materials, including the rails and fastenings, were furnished by the contractors, and the whole work is strictly up to requirement.

The barge or caisson was built under a contract with Messrs. H. T. Morrison & Co., of Petersburg, Va., and is also in every respect according to contract.

The locomotive, a second-handed tank engine, weighing, with fuel and water, 36,250 pounds, which had been put in good order before its purchase, was furnished by the Tredegar Company, who also furnished a model iron dumping car.

About twenty dumping cars will be needed to keep two ordinary dredges supplied.

Amount dredged during the year.

Locality.	Sand, gravel, and clay.	Decomposed rock.	Solid rock.
	Cub. yards.	*Cub. yards.*	*Cub. yards.*
City limits to Stearns Dike		10,620.5	162.0
Stearns Dike to Goodes Rocks		5,192.9	40.8
Goodes Rocks		4,244.9	5,044.8
Richmond Bar	9,342.8		722.8
Randolph Flats	34,018.6		163.8
Kingsland Reach	44,918.8		132.0
Dutch Gap	13,545.4		
Total	101,825.6	20,058.3	6,265.7

FRESHETS.

No heavy freshets have occurred. The following rises have been noted above low tide:

	Feet.
August 25, 1891	8.3
January 16, 1892	13.5
January 21, 1892	11.6
March 1, 1892	7.8
March 10, 1892	8.7
April 24, 1892	9.4

The completion of the work in Kingsland Reach and the further removal of the slide of 1889 in Dutch Gap have been of benefit to navigation. The depths of channels elsewhere have generally been maintained with some improvement due to contraction and dredging. The work done in the rocky bottom for 2 or 3 miles below Richmond has been a further progress towards a wider and deeper channel there,

but no improvement in available depth from the sea to the city can be reported from the last year, which was 16¼ feet at full tide.

All the depths mentioned in this report, except when otherwise specified, are referred to the datum line, which is mean low tide; and the widths, surfaces, and areas in cross section and heights of freshets are also given for the same stage of water.

The mean rise and fall of tide at Richmond is 3.6 feet; at City Point, 2.5 feet; at the junction with the Chickahominy, 2 feet; and at Newport News, 2.5 feet.

Returning to this work after an interval of ten years, in which the plan of the improvement has been considerably enlarged by law, and large amounts of work done in excavation and in constructing regulating dikes and wing dams, it has been necessary for me to examine the successive maps and reports made in the interval and before in order to learn what has been done from year to year and the results. Some of the more important facts collected in this way are shown in this report and more clearly in the appended maps and statements. The progress of the improvement, especially in the 14 miles nearest Richmond, has been steady, and appears to be permanent.

The characteristics of James River have been stated in your previous reports, and only a brief description will be given now.

The river begins at the confluence of the Jackson and Cowpasture rivers, a few miles east of Clifton Forge, in Alleghany County, Va., and is 234¼ miles long to the head of tide at Richmond. In this distance it falls 1,018¼ feet, an average of 4.34 to the mile, and in the last 10 miles above tide-water it falls 124 feet over a bed of granitic rock. The tributaries mentioned have their sources on the eastern slope of the Alleghany Mountains and in ridges parallel to and eastward of that range.

The James, at Richmond, carries the drainage of more than 7,000 square miles, and that which enters the river below Richmond makes the total area drained about 10,500 square miles. Perhaps one-half of this area is mountainous, and the discharge is subject to great fluctuations and to violent freshets, which have been frequent in recent years.

The lowest gauging noted was in 1881, when the city engineer found it 800 cubic feet a second. His estimate of the normal low-water discharge is 1,332 cubic feet. In the freshet of November, 1877, which was 28.6 feet above datum line at Rocketts, Richmond, the highest rise of which there is an authentic record, it is probable that the discharge at the height of the freshet was 200,000 cubic feet a second.

The fall below Richmond is inconsiderable at ordinary stages. It amounts to less than three-tenths of a foot in the 14 miles to Dutch Gap, and can scarcely amount to a foot in the whole distance to Newport News.

For 7 miles below Richmond the river flows directly south with slight curvature; it then turns eastward and is very tortuous to its junction with the Appomattox, 30 miles below. In the remaining 97 miles to its mouth there are several bends, but the curvature is much less than in the middle section.

The physical conditions of the river in tide waters are well and concisely stated by Mr. Burgwyn in his report of 1882 to Capt. Thomas Turtle, Corps of Engineers, made after the elaborate survey of 1881, about as follows:

"From these considerations it appears that the river has three distinct conditions of location. The first is where the river is subject to freshet action exclusively. The third is where the river is entirely governed by tidal considerations, and a middle section where first the tides and then freshets have the greater influence. The boundaries of these sections so blend into one another that it is not possible to define their limits exactly, and they probably vary with each particular freshet; but as the river suddenly deepens at Drewry Bluff and maintains this depth for some distance, this is taken as the end of the first section. The second naturally ends at City Point, and the third extends from thence to the sea."

For nearly 2 miles below the city limits the bed of the river is in rock, mainly soft or disintegrated granite containing hard bowlders of considerable size and reefs of hard granite or gneiss; the most considerable of which is known as Goodes Rocks. This rocky bed was formerly covered with a stratum of sand, also containing many bowlders. The sand has been almost completely swept off by the current caused by works of regulation, and the bowlders in and near the channel have been removed by dredges and other appliances.

This rocky bed is about 16 feet below datum line at the head of Richmond Bar, and thence slopes rapidly to more than 22 feet, and afterward makes its appearance in a few isolated points only, of small area and of no obstruction to the channel.

From Richmond Bar to the end of the first section, mentioned by Mr. Burgwyn, the river bed is in sand resting at varying and generally increasing depths on a bed of coarse gravel, containing some large bowlders, and for a short distance below the bar of small areas of soft rock 20 or more feet below low tide.

The bar itself, except at its head, is now of compact gravel and cobble, with the usual large bowlders. It was formerly covered with from 7 to 8 feet of sand, which has been entirely swept away from between the works of contraction.

In the rocky section above the bar the work of improvement is now exclusively in excavation, although the width of the river has been contracted by dikes and wing dams, owing to which the channels when evenly cut to a regular depth are not liable to obstructions by deposits from the river. In the remaining part of the first section mentioned above, the improvement has been made by contraction aided by dredging.

Between Drewry Bluff and City Point the river is generally of considerable depth, with shoal areas at intervals, almost always where the current changes from one bank to the other, where also the river surface exceeds its average width. From experience with three of these shoals it is clear that contraction rather than dredging is needed on this part of the river. Below City Point the river becomes broader and deeper, rather an estuary than part of the river. The shoals which require deepening are few, although individually they are of greater extent than those between Drewry Bluff and City Point.

From experience thus far, it is probable that channels of the desired depth can be maintained more economically by occasional dredging than by the construction of dikes, but experience has been limited with channels cut deeper than 18 feet below datum line, and regulating works may be found more economical than dredging in the maintenance of some of the channels when dredged to the enlarged plan.

HISTORY OF THE IMPROVEMENT.

The river was surveyed by Claudius Crozet in 1826 under the direction of the board of public works of Virginia, but no action was taken as the result of it. Another survey was made by Capt. Howard Stansbury, Assistant U. S. Engineer, in 1836, and a third in 1852 by the U. S. Coast Survey. In the last-named year Congress made an appropriation of $45,000 for the improvement of the James and Appomattox rivers. One-half of this was expended on the James under the direction of Col. De Russy on behalf of the United States, who was aided by a committee of Richmond city council, the city having appropriated $21,300 to the work. This expenditure was of considerable advantage, in the removal of the more dangerous rocks and in maintaining somewhat deeper channels over the bars. The appropriation was exhausted in 1855. After that some work was done by the city, but no further appropriation was made by Congress until 1870. In that year Congress appropriated $50,000 and the city $250,000. A large part of the latter was expended in dredges and other machinery, and in acquiring the land for Dutch Gap Cut-off. The Congressional appropriation was mainly expended in removing obstructions placed in the river during the civil war and in opening Dutch Gap Cut-off.

The obstructions were lines of cribs and sunken vessels placed by the Confederate authorities at Warwick Bar, Drewry Bluff, and Kingsland Reach, and military bridges above Drewry Bluff. These were removed sufficiently so as not to interfere with navigation, and some of them completely. A cut through the narrow neck at Dutch Gap had been made by the forces under Gen. B. F. Butler during the civil war, but was too contracted for the passage of large vessels, and a causeway had been built across the upper entrance. This was washed out by the freshet of 1870, and the cut was then enlarged and deepened by the United States.

The survey made under your instructions in 1874 by Mr. William Popp was more in detail than any which preceded it, and remains the standard to which others on this part of the river are usually referred. It showed that the obstructions placed in the river did no permanent injury to its navigation. The depths on Richmond and Warwick bars were practically the same in 1836, 1852, and 1870. The crest of Warwick Bar had moved 2,000 feet above, but its depth was the same as formerly at the old site. The only material change noted was in Trent Reach, in the bend cut off by Dutch Gap, which in 1852 had a depth of 10 feet, and but 8 feet in 1874 after some dredging. This change may have followed the opening of Dutch Gap Cut Off, which caused a diversion of part of the river.

A great freshet occurred on September 5, 1870. It rose to 27 feet above low tide at Rocketts; as results the depths on Richmond Bar and in Trent Reach were reduced to 7 feet and correspondingly at some other points. The larger New York steamships ceased to run to the city for several months.

Such was the condition of the river in 1870, before the recent work of improvement was begun; and the channel limited in depth to 10½ feet at full tide for 14 miles below the city, was further impaired by obstructions natural and artificial, by bowlders and wrecks and sunken cribs and vessels. The artificial obstructions were removed by the United States, as before stated. The dredging through the shoals was at first done by the city, the intention being to get 15 feet at full tide from below Richmond Bar. Dikes were also begun to regulate the river widths and close minor channels, as at Drewry Island, and to retain the material excavated from the main channel.

A cut was made through Richmond Bar 75 feet wide by 11½ feet deep at low tide,

but at the date of the survey in 1874 this had been reduced to 8¼ feet by deposits from the river. The mean surface width on this bar in 1874 was 1,022 feet, and its mean area in cross-section 6,331 square feet. Its mean depth was 6.45 feet and its available depth for navigation in a channel 80 feet wide was 8.2 feet at mean low tide. The condition of this and other shoals above Drewry Bluff at this time compared with 1890 are given in Statement A, appended. The aim of the improvement had now been fixed by the engineer officer in charge to obtain 18 feet at full tide from the sea to Richmond, with a depth of not less than 15 feet at low tide in rock. The width of the channel was to be 180 feet.

In 1874 a dike was built on the left bank at Richmond Bar, contracting the river width to 900 feet, and a channel 120 feet wide by 15 feet deep was dredged. This gave an area in cross section between the dike and the right bank of 6,639 square feet. The freshet of February, 1875, 14.4 feet above datum line, reduced the depth again to 11¼ feet, and this for a narrow strip, and the area to 6,165 feet. In July, 1875, a training wall of stone and timber wing dams were constructed on the right bank, covering about 1,100 feet of the bar, which reduced the width uniformly to 775 feet. The wing dams were built to the level of high tide at their channel ends, and about 1 foot higher at the shore. No further dredging was done at the time. There was no rise in the river for several months, and no effect of the tidal current was noted other than a rounding out of the bed, which still showed traces of the last previous dredging. The river rose 8¼ feet above its usual stage in March, 1876, and was above its ordinary stage for more than a week. The result was an increase in depth of channel to 12 feet, and an increase in average area to 6,590 feet. After this the widths on this bar were further contracted from time to time, until the present widths of from 426 to 467 feet were attained in 1881; intended to produce the depth of 15 feet as required by the plan of that date.

This depth was attained and has since been maintained, but no dredging has materially increased it, except temporarily, nor has the area of 1876 been exceeded. The mean cross section for the bar 3,500 feet, long is now 6,211 feet, with a maximum of 6,544 and a minimum of 5,686. There is a wide channel over it with not less than 15 feet at low tide. The material remaining is such as yields slowly, if at all, to the currents. A further contraction will doubtless maintain a deeper channel, but dredging is necessary to obtain it.

Contraction by wing dams and dikes were made on other shoals as far down as Warwick Bar before 1881, and with good results. During this time also the channel through the section above Richmond Bar was widened and deepened, and included also channels through Rockets Reef and Gillies Creek shoals, which are within the city limits. No considerable work has been done for a few years past by the United States within the city limits, and this part of the river is now in charge of the city engineer through the James River improvement committee.

The channels at Varina and Curles Neck, which are between Dutch Gap and City Point, and those at Harrison Bar, Swan Point, and Goose Hill Flats, which are below City Point, were deepened to 18 feet. Wing dams were constructed at Varina which caused a considerable improvement, even in the dredged channel and elsewhere, up to as late as 1884. At some later date the upper dams, which had not been revetted with stone, were much shortened by a freshet, and changes were made in their shore ends which may have further impaired their efficiency. The channel is now shoaling wherever the wing dams were shortened, but not elsewhere. The channel at Curles Neck is also silting up and returning to its former condition. The available depth has been reduced from 18 feet, to which it had been dredged, to about 15½ feet, as found by the survey of 1890. The shoal is at a crossover with the usual accompaniment of more than the average width. The means were not at command in 1881 for contraction as well as dredging, and it was hoped that dredging would suffice. It is evident that on all the shoals between Richmond and City Point, which are formed by matter now transported by the river, a contraction of the sectional area is needed to maintain a deeper channel than has been formed by nature, and that in most cases the depth required by the plan of improvement may be had by contraction alone, although it would be hastened by dredging; and dredging may be found necessary within limited areas.

The channels at Harrison Bar and Goose Hill Flats, which are below City Point, show some changes since they were dredged to 18 feet in 1880. The crest of the former has lowered a little, while the flat opposite Westover, over a mile below, shows but 17.2 feet in places. The upper entrance to the channel through Goose Hill Flats is narrowed, but retains its full depths.

The middle section of the channel for 2,000 feet has shoaled so that in spots there are but little over 17 feet. The channel at Swan Point was deepened from 18 feet in 1880 to over 20 feet in 1885, and has not been examined since.

A very thorough examination of the river was made in 1881, under your direction, in compliance with a resolution of Congress directing a report on the practicability and cost of deepening the channel from the sea to Richmond to 25 feet at full tide.

The estimate for this was submitted in your report of 1882, and Congress adopted the plan in July, 1884.

Since then the work has been prosecuted with that end in view.

The most tedious part of the work is in the rocky bed for 2 miles below the city limits. Work was begun at Goodes Rocks, the largest area of solid rock, in 1884. The channel lines were moved 50 feet to the right to give greater directness to the current and allow blasting to be done with less danger to navigation. The cut is now 55 feet wide and about 500 feet long in the most solid part of the reef. It should be made at least 100 feet wide before it is opened to navigation. Between this cut and Richmond Bar below, and also between it and the city limits above, a large percentage has already been excavated to a depth of 18 feet and a considerable area to 22 feet. The quantities remaining between the city and bar are as follows for the widths and depths of channel stated:

Locality.	Widths and depths.		
	200 by 22 feet.	150 by 22 feet.	100 by 22 feet.
	Cubic yds.	*Cubic yds.*	*Cubic yds.*
City limits to Goodes Rocks	325,571	219,971	....
Through Goodes Rocks to Richmond Bar	62,692	39,169	20,826
Total	388,263	259,140	20,826

A channel 150 feet wide and 18 feet deep above Goodes Rocks contains but 70,812 cubic yards in place, as against 219,971 cubic yards for the full depth. There are reasons for not pushing the excavation on this part of the river to the full depth at once, except in solid rock, which can not be removed without blasting. One of these reasons has been given already; another is, that an additional depth of even a foot is a great benefit to navigation and may be attained with the means afforded by Congress from time to time, while the full depth can not be, except in patches. A greater width rather than a large increase in depth is now needed below the city limits, where the channel of about 16 feet depth is now but 80 feet wide for some distance. In solid rock which is not softened by exposure, where blasting is necessary, the excavation should be carried to the full depth, and this has been the practice on this improvement.

The proportion of solid rock excavated at Goodes Rocks was 54.2 per cent in the past year; while above it was but 1.25; the remainder in each case being soft rock. But no blasting was done in the latter part, the solid rock measured consisting of bowlders. If the hard rock had also been removed its percentage would perhaps have been 20. The cost of solid as compared with soft rock in the past year has been from 5¼ to nearly 14 to 1 a cubic yard.

It has been stated that the widths between the dikes and wing dams on Richmond Bar were intended to maintain a channel of 15 feet depth; which was the scope of the improvement at the time; the widths between the works of regulation, built since 1884 for the present plan, are much narrower. A cut was dredged through this bar in 1889-'90 to a depth of about 20 feet, and a similar cut was made for 900 feet below its head in 1891. Both these cuts were filled, in subsequent freshets, by rounding out the sides of the cuts, and by deposits; so that there is no greater available depth now than in 1888, although there is some additional width in cross sections. The widths on this bar should be adjusted to the plan of 1884, and a wide channel dredged through its hard material. This, of coarse gravel and cobble, as well as the rock excavated above, will be needed to revet the dikes and wing dams to be constructed there and elsewhere. An average contraction of 80 feet seems to be indicated to maintain a channel of 200 by 22 feet, the dimensions of the channel proposed at that point.

The lines of contraction below this bar have been completed to Drewry Bluff, so far as means would permit, and give encouraging results. From an inspection of the column under May, 1892, in statement C, it seems practicable, with some inconsiderable changes in width, to secure a good channel there with 18 feet depth, in the next year, without dredging, except at wing dams 91 and 92, where there are probably some remains of the cribs placed on Warwick Bar during the civil war. These it will be necessary to remove by dredging, and possibly after blasting, to the full depth and width of the new channel.

It is not unlikely that a further contraction will be needed here at several points to maintain the full-sized channel; and a small amount of repairs to dams injured by freshets, and some alterations in the lines of the crossover at Falling Creek, and wing dams at certain points to protect the banks of the river are needed now. There has not been time enough since the contractions were made to enable me to say how much more is required, or to warrant further expenditure on this section at present,

except as above stated. The work can be completed hereafter as required, to keep pace with the probably slower increase in depth above Richmond Bar.

Maps of Richmond Bar and Randolph Flats are submitted showing the conditions in 1874 and by the most recent survey, and will aid in making the description of these parts of the river more easily understood.

The scour produced by the contraction above Drewry Bluff, in 6 miles of the river, and particularly on the lower 4 miles, amounting to perhaps 450,000 cubic yards in excess of the amount excavated by machines, has caused shoaling below. The mean depth of deposit for about 3 miles below the wing dams in thirteen years following the survey of 1874 was about 2 feet and measured 684,575 cubic yards. This was accompanied by a contraction of the mean surface width of 13 feet, and a reduction in cross section from 10,555 to 9,297 square feet. The deposit is not uniform, being greater on the shoals where the surface width is greater than the average. This computation was not carried to a lower point for want of time, but there has been no unfavorable change in the widths and depths at 7 miles below the wing dams near Dutch Gap as is shown later in this report.

There are two of these crossover shoals in the 3 miles referred to, one between Drewry and Chaffin bluffs, where the navigable depth is now 16¼ as against 22 feet in 1874; the other just above Willis Wharf, where the reduction has been from 19 to 17 feet. There has been no apparent reduction in depth at either point since 1887. A suitable contraction in surface width is all that appears necessary at these points.

The obstructions placed in the river at Drewry Bluff (1861–'65) caused a considerable scour for 1,500 feet below.

They were removed to a depth of about 20 feet in 1871–'72, the depth of the former bed being from 24 to 28 feet for over 200 feet of its width. The depth of this scour remaining in 1874 was from 8 feet near the obstructions to 2 feet 1,500 feet below, under the old bed, as shown by the survey of 1852. This scour has now been filled by deposit, and the river bed has nearly its old profile.

There is ample depth and width of channel above and below the remains of these obstructions, but on their line, for about 50 feet in width, there are less than 22 feet in depth, and less than 20 feet on an area of 200 by 40 feet in the present fairway, with one sounding of less than 18 feet.

It would be better to remove these to the old river bed, and something is necessary to provide a channel of the required dimensions.

Full reference to the shoal in Kingsland Reach has been made elsewhere. Between it and Dutch Gap, 14 miles below Richmond, there is nothing which needs immediate attention. There is a crossover with but little over 18 feet, where contraction is needed for the depth of 22 feet.

Maps Nos. 3 and 4 will show the width and depths in Dutch Gap Cut-off in 1870 and in May, 1892. Map No. 5 shows the bend cut-off and the river for a short distance above and below the gap, with cross sections giving the comparative conditions of the bend in 1874 and 1887, and of the river above and below in 1852 and 1890. Plate No. 6 shows a profile of the old neck as nearly as can be made from data in this office, and a comparative profile of the bed of river above and below it in 1852 and 1890.

The calculations of mean dimensions show no changes injurious to navigation in the river near the gap. The results are given in statements below.

The channel hugged the shore on each side of the narrow neck of land existing before the cut was made, which was 640 feet wide between contours of 18 feet below low tide in 1852, and the currents may have been slowly wearing it away. The material to a few feet above high tide is a very hard clay, yielding with difficulty to any dredge heretofore employed on the work unless blasting was resorted to. Above this is gravel and sand covered with yellow clay. The bottom of the cut wears very slowly under the current, is about 10 feet higher than the bed of the river just above, and is a submerged dam. The current in the cut is strong even at low stages of the river, except when the tide is at a stand, and is very strong in freshets. The surface slope through the cut and elsewhere, in the great freshets noted, was as follows: The distance through the gap being 600 feet and around the bend 25,730 feet. The heights are given above datum line, or low tide at each place. The slopes from Richmond to the gap include the 0.3 foot found at low tide between these points.

Year.	Surface above datum line.			Fall, Richmond to gap, on low tide.	Fall through gap.	Absolute slope of surface, Richmond to gap.	Slope of surface through gap.	Slope of surface around the bend.
	At Richmond.	At gap, upper end.	At gap, lower end.					
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
1877..........	22.62	17.84	15.69	10.88	2.15	1 in 6,612	1 in 279	1 in 11,963
1886..........	24.28	13.12	11.38	11.16	1.74	1 in 6,450	1 in 345	1 in 14,787
1889..........	26.18	14.16	12.10	12.02	2.06	1 in 6,000	1 in 291	1 in 12,490

This current meeting the flow around the bend at nearly a right angle has caused a great scour immediately below the cut and changed the channel for some 2,000 feet below, so that the lower entrance is now made more directly by ascending vessels. The current is also slowly abrading its hard clay bed at the lower entrance and has probably cut away an average of more than 80 feet from its lower edge at 22 feet depth, with a slope extending to 50 feet in depth in a distance of 120 horizontal.

In 1877 the cut was about 180 feet wide by 15 feet deep. It was enlarged in 1879 to 200 feet, with entrances of 300 feet, and was deepened to 18 feet in 1880. It was widened throughout to 300 feet in 1889, and has since been enlarged as heretofore stated and as shown on Map No. 4. It will be noted that the surface slope between Richmond and the gap in great freshets has increased with the enlargement of the cutting.

At some future time the cut should be deepened to the level of the river bed above or to about 30 feet below datum line. Nor would this be a serious undertaking, as it is but 540 feet between 22 feet contours, sloping sharply to 30 feet on both sides.

The angle turned by a ship passing through the gap is 158° in about 2,200 feet, and a curve of 750 feet radius is the best practicable. A cut-off from about 2 miles above, which would save a mile or more of distance and require a mile of cutting, has been considered. This would greatly improve the entrance and exit of the cut and remove more than half the curvature stated, and would also avoid one of the sharpest bends in the river, at the upper end of Devil's Reach. The cost of this would be more than is warranted by the usual appropriations for this improvement.

The river for 1,220 feet above and 2,570 feet below Dutch Gap, 1874 and 1890.

	1874.	1890.	Increase.	Decrease.
Above the gap.				
Number of sections taken	5	10	....	....
Mean width at low tide ... feet	495	549.7	54.7	....
Mean depth at low tide ... do	22.65	20.97	....	1.68
Average center depth ... do	37.7	37.1	....	0.6
Mean area ... square feet	11,209.4	11,528.2	318.8	....
Solids of water ... cubic feet	13,675,425	14,370,610	695,185	....
Below the gap.				
Number of sections taken	12	11	....	....
Mean width at low tide ... feet	647.2	667.5	20.3	....
Mean depth at low tide ... do	23.0	23.02	0.02	....
Average center depth ... do	39.0	40.7	1.7	....
Mean area ... square feet	14,908	1,536.7	459	....
Solids ... cubic feet	38,313,365	39,593,245	1,279,810	....

In the bend cut-off, which is about 5 miles long, the amount of deposit from 1874 to 1887, the date of the most recent survey, was 5,325,115 cubic yards, or 47¾ per cent of the whole volume of water in the bend at low tide in 1874. It is no longer navigable at low tide for vessels drawing more than 5 feet.

The whole amount of material dredged and blasted in twenty years, in 6 miles below Richmond, added to the amount scoured from between the wing dams, is probably less than 1,500,000 cubic yards. This deposit, as well as that forming behind all the dikes, has come from above Richmond, except perhaps 160,000 cubic yards excavated from the gap previous to 1887 and deposited there, and when it is remembered that a large part of the silt-laden water does not enter the bend, but escapes by the cut-off, and that only a part of the silt entering the bend is left there, the remainder passing on, and that this transportation of solid matter has been going on for uncounted years in quantities of which we have little apprehension, and that the navigable condition of the river has probably not depreciated in nearly three hundred years, there should be no apprehension that the channel will be silted up, or that the intended depth of improvement can not be maintained. It can be made self-sustaining so long as the drainage of the James is not seriously diminished.

A table of wing dams from the head of Richmond Bar to Drewry Bluff will be found in Statement C, which gives the original widths and sections of the river at their sites in 1874 with the best depth for 80 feet wide, and corresponding items from 12 subsequent surveys, giving the progress of the contraction, the amounts dredged from time to time, and the freshets of which records have been kept.

I have selected from this table the wing dams from Nos. 55-56 to 95-96, covering 1¼ miles of river, where there are works of regulation on both sides, although six of the dams on one side were shortened an average of 21 feet by freshets, to show the comparative effects of two great freshets which occurred in 1889, and of twelve small freshets

occurring between August, 1889, and September, 1891, and of four others since January, 1892. About 350,000 cubic yards had been dredged from this section before the first freshet of 1889, and a survey had been made here a few days previous. The average depths of the channel at low tide will be found as follows: In 1874, 13.82 feet; May, 1889, previous to the freshet, 18.02 feet; August, 1889, after the two freshets, 19.19 feet, September, 1891, after the twelve small freshets, 18.70 feet, and in May, 1892, 18.58 feet. The channel now averages 0.5 foot deeper than after the dredging of 1889, but 0.61 less than after the freshets of that year, and is 4¾ feet deeper than in 1874.

The present depths of the river at mean low tide, compared with those of 1870 in a channel not less than 80 feet wide, is as follows:

	1870.	1892.
	Feet.	*Feet.*
From the city to Richmond Bar	7.0	13.8
Over Richmond Bar and Randolph Flats	7.0	15.0
From Randolph Flats over Warwick Bar	12.4	15.4
From Warwick Bar to City Point (Trents Reach in 1870)*	7.0	15.5
From City Point to the sea	14.8	17.0

*Trents Reach is now avoided by Dutch Gap Cut-off.

And the present available depth to navigation at full tide, as stated elsewhere, is 18¼ feet from the sea to Warwick Bar, and from Warwick Bar to the Chesapeake and Ohio Railway wharves is 16¼ feet; these depths above Warwick Bar being somewhat less than the actual depths stated above.

Very respectfully, your obedient servant,

H. D. WHITCOMB,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers.

STATEMENT A.—*Comparison of widths, areas, depths, and solids before and after contraction on six sections of James River, between Richmond City limits and Drewry Bluff.*

[All measurements at mean low tide. Distances, widths, areas, and depths in feet. Solids in cubic yards.]

Sections.	Length of sections.	Works of contraction.		Areas in 1874.		Areas between present contraction lines.			
		Begun.	Latest extension.	Mean.	Ranging from—	Mean 1874.	Ranging from—	Mean 1891.	Ranging from—
City limits to Richmond Bar	9,061	1876	1889	5,709	4,686– 7,330	4,617	3,838–6,217	5,449	1,011–6,829
Richmond Bar	3,530	1875	1882	6,831	5,518– 7,335	3,674	3,236–4,887	6.211	5,686–6,544
Randolph Flats	3,251	1876	1888	6,558	5,670– 7,193	4,112	3,579–4,618	6,945	6,211–7,299
Randolph Flats to Warwick Bar	8,189	1877	1888	8,298	7,295–10,313	5,599	4,727–7,997	7,854	6,783–8,209
Warwick Bar to Falling Creek	5,656	1877	1887	9,026	8,104–10,137	8,047	7,344–8,627	8,487	8,046–8,785
Falling Creek to Drewry Bluff	3,667	1887	1891	10,052	....	9,237	....	8,785	....

Sections.	Mean width.		Mean depth.		Depth available for navigation 80 feet wide.		Solids of water in 1874.	Solids within lines of contraction of 1891 in—		Increase since contraction.
	1874.	1891.	1874.	1891.	1874.	1891.		1874.	1891.	
City limits to Richmond Bar	718	438	7.93	12.44	9.4	13.8	1,915,891	1.549,323	1,828,551	279,228
Richmond Bar	1,022	434	6.45	14.30	8.2	15.0	862,469	512,578	812,024	299,446
Randolph Flats	1,013	416	6.47	16.70	9.2	16.3	789,640	495,133	836,200	341,067
Randolph Flats to Warwick Bar	834	434	9.95	17.47	12.4	15.4	2,516,781	1,698,173	2,299,747	601,574
Warwick Bar to Falling Creek	664	551	13.59	15.42	16.6	16.3	1,890,671	1,685,874	1,773,791	87,917
Falling Creek to Drewry Bluff	719	551	13.97	15.96	20.4	21.0	1,365,280	1,254,542	1,193,169	....

	......do	570	7,705	14.5	16.8	565
	......do	590	8,113	15.7	19.8	584
	......do	590	7,822	14.7	15.4	590
	......do	605	8,074	14.8	16.4	600
	......do	650	8,228	16.5	17.4	690
	......do	660	8,375	17.4	19.8	655
	......do					
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
Falling Creek Shoal	Crosses to right bank	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	Curve to left along right bank	......	......	......	......	......
Above Drewry Bluff	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......
	......do	......	......	......	......	......

his stretch from 1874 to 1892.

1882.	
Ving dams.	Cubic yards.
45–61	10,300
1883.	
45–61	10,500
......	......
......	......
......	......

* Monitor fleet.

STATEMENT B.—*Comparison of widths, areas, depths, and solids between Drewry Bluff and Willis Wharf by surveys of 1874 and 1877; distance, 14,690 feet.*

[All measurements at mean low tide. Distances, widths, areas, and depths in feet. Solids in cubic yards.]

Sections.	Length of sections.	Surface widths in 1874.		Surface widths in 1887.		Mean surface area in 1874.	Mean surface area in 1887.	Greatest depths in 1874.	Range of greatest depths in 1874.	Greatest depths in 1887.	Range of greatest depths in 1887.	Mean depths in 1874.
		Mean.	Ranging from—	Mean.	Ranging from—							
Wing dam No. 150 to cross over below Drewry Bluff, on curve left	2,540	596	520–730	580	500–660	1,514,401	1,473,275	42	23.8–42	30.3	20.3–30.3	16.6
Drewry to Chaffin Bluff, a cross over right to left	4,450	579	440–680	599	500–660	2,574,440	2,666,375	37	22.5–37	30.8	17.3–30.8	18.7
Along Chaffin Bluff, on curve right	4,635	599	500–700	568	400–710	2,776,275	2,633,400	44.8	23.8–44.8	41.1	23.5–41.1	17.9
Chaffin Bluff to Willis Wharf, a cross over left to right	3,065	690	620–750	656	560–730	2,114,125	2,011,925	25.5	19.2–25.5	22.8	17.6–22.8	15.3
Totals from No. 150 to Willis Wharf	14,690	611.25	440–750	598.02	400–730	8,979,241	8,784,975	44.8	19.2–44.8	41.1	17.3–41.1	17.27

Sections.	Range of depths in 1874.	Depths in 1887.		Areas in cross section in 1874.		Areas in cross section in 1887.		Solids of water in 1874.	Solids of water in 1887.	Amount of deposit from 1874 to 1887.	Range in depths of deposit, 1874–1887.
		Mean.	Ranging from—	Mean.	Ranging from—	Mean.	Ranging from—				
Wing dam No. 150 to cross over below Drewry Bluff, on curve left	12.3–21.1	15.2	13.6–17.2	9,905	8,616–13,540	9,158	7,602–9,744	931,819	830,928	100,891	−1.75–+5.2
Drewry to Chaffin Bluff, a cross over right to left	15.1–23.0	15.4	12.3–19.1	10,814	8,436–13,085	9,247	8,221–10,810	1,782,260	1,524,104	258,156	− .7–+7.0
Along Chaffin Bluff, on curve right	16.0–24.9	16.8	13.3–24.0	10,622	9,012–12,972	9,561	8,585–11,129	1,832,054	1,641,245	190,809	−0.65–+4.0
Chaffin Bluff to Willis Wharf, a cross over left to right	13.7–17.1	14.25	12.8–18.6	10,541	9,009–11,214	9,354	8,829–10,431	1,196,572	1,061,853	134,719	+ .2–+1.9
Totals from No. 150 to Willis Wharf	12.3–24.9	15.55	12.8–24.0	10,555	8,436–13,540	9,297	7,602–11,129	5,742,705	5,058,130	684,575	−1.75–+7.0

COMMERCIAL STATISTICS.

[Richmond, Va., Custom House Report.]

Vessels, steam and sail.

Year ending June 30—	Cleared.	Entered.	Tonnage cleared.	Tonnage entered.	Value of exports.	Value of imports.
1891	372	427	308, 177	337, 982	$195, 072	$26, 486
1892	421	448	359, 298	381, 141	138, 756	10. 180

The vessels varied in draft from 6 to 26 feet.

Shipped from other points on the river excluding Richmond.

	Tons.
Grain	3, 167
Lumber	123, 180
Railroad ties	38, 854
Live cattle	157
Cord wood	90, 614
Hay, shucks, etc	1, 313
Miscellaneous	42, 853
Total	300, 138

Received at other points on the river excluding Richmond.

	Tons.
Coal	575
Lumber	1, 000
Fertilizers	190
Miscellaneous	15, 046
Total	16, 811

Shipped from Richmond.

	Tons.
Coal	20, 000
Cotton	5, 500
Flour	5, 531
Miscellaneous	52, 189
Total	83, 220

Received at Richmond.

	Tons.
Coal	62, 000
Cotton	1, 476
Grain	3, 500
Lime, cement, and plaster	13, 210
Ice	35, 000
Miscellaneous	101, 400
Total	216, 586

Totals, points on the river and Richmond.

	Tons.
Shipped:	
Coal	20, 000
Cotton	5, 500
Grain	3, 167
Lumber	123, 180
Flour	5, 531
Live cattle	157
Cord wood	90, 614
Hay, shucks, etc	1, 313
Railroad ties	38, 854
Miscellaneous	95, 042
Total	383, 358

Received—	Tons.
Coal	62,575
Cotton	1,476
Grain	3,500
Lumber	1,000
Lime, cement, and plaster	13,210
Fertilizers	190
Ice	35,000
Miscellaneous	116,446
Total	233,397

APPENDIX J.

IMPROVEMENT OF POTOMAC RIVER AND ITS TRIBUTARIES, OF HARBOR AT BRETON BAY, MARYLAND, AND OF CERTAIN RIVERS ON WESTERN SHORE OF CHESAPEAKE BAY, MARYLAND AND VIRGINIA.

REPORT OF MAJOR CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Potomac River at Washington, District of Columbia.
2. Potomac River at Mount Vernon, Virginia.
3. Occoquan Creek, Virginia.
4. Aquia Creek, Virginia.
5. Harbor at Breton Bay, Maryland.
6. Nomini Creek, Virginia.
7. Patuxent River, Maryland.
8. Rappahannock River, Virginia.
9. Urbana Creek, Virginia.
10. York River, Virginia.
11. Mattaponi River, Virginia.
12. Pamunkey River, Virginia.

EXAMINATIONS AND SURVEYS.

13. Eastern Branch of the Potomac River (Anacostia River), District of Columbia.
14. Potomac River up to Washington.
15. Harbor of refuge in Lynnhaven Bay, at foot of Chesapeake Bay, Virginia.

HARBOR LINES.

16. Establishment of harbor lines in Anacostia River (Eastern Branch of the Potomac), at Washington, District of Columbia.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 9, 1892.

GENERAL: I have the honor to forward herewith my annual report for the year ending June 30, 1892, on river and harbor works in my charge.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

ORIGINAL CONDITION.

Previous to this improvement the channel to Georgetown, D. C., was narrow and crooked, so that vessels drawing 16 feet of water often grounded above Long Bridge, and frequent dredging became necessary to maintain even this depth. On account of the smallness of the appropriations only narrow cuts could be dredged, entirely inadequate to the needs of commerce. The Washington Channel was also narrow and shoal.

From Observatory Hill to a point abreast of the Arsenal large flats had formed, separated from the mainland below Long Bridge by the Washington Channel, with its sluggish currents, due to the ebb and flow of the tides. These flats were alternately covered and exposed to the sun's rays by the tide, whose average rise and fall at Washington is 3 feet, while the large sewer at the foot of Seventeenth street NW. discharged directly upon them.

These conditions combined to generate an effluvium that became an intolerable nuisance, rendering certain portions of the city almost uninhabitable, and really endangering the health of the city.

PLAN OF IMPROVEMENT.

The proposed plan of improvement adopted by the act of Congress of August 2, 1882, has for its object to improve the navigation of the river by widening and deepening its channels; to reclaim or fill in the flats by depositing on them the material dredged from the channels; to purify the water in the Washington Channel, and to establish harbor lines beyond which no wharves or obstructions shall be built.

To accomplish these purposes such depths of channels are to be provided as will accommodate the largest vessels that can reach Arsenal Point, with such depths at the wharves as will allow vessels to receive full cargoes without grounding at low water; the Flats above Long Bridge are to be filled in to a height of 3 feet above the flood line of 1877; below Long Bridge the middle line of the Flats is to be filled up to the same height, but the Flats are to slope each way to a height of 6 feet above low tide at the margin of the fill; to purify the water in the Washington Channel, cut off at its upper end from the Virginia or Main Channel, a tidal reservoir or basin is to be established above Long Bridge, to be filled with water from the Virginia Channel on the flood tide, and discharged into the Washington Channel on the ebb.

The project also provides for the rebuilding of the Long Bridge at an early period during the progress of the improvements, with wide spans, upon piers offering the least possible obstruction to the flow of water, and the interception of all sewage now discharged into the Washington Channel and its conveyance to the James Creek sewer canal; but neither of these two works was included in the estimated cost of the improvement, which is $2,716,365.

Appropriations have been made as follows:

Act of—	
August 2, 1882	$400,000
July 5, 1884	500,000
August 5, 1886	375,000
August 11, 1888	300,000
September 19, 1890	280,000
July 13, 1892	200,000
Total	**2,055,000**

The act of August 2, 1882, contained the following clause:

And it is hereby made the duty of the Attorney-General to examine all claims of the title to the premises to be improved under this appropriation, and to see that the rights of the Government in all respects are secured and protected; and if he deems it necessary he is authorized to cause a suit or suits in law or in equity to be instituted in the name of the United States, in the supreme court of the District of Columbia, against any and all claimants of title under any patent which in his opinion was by mistake or was improperly or illegally issued for any part of the marshes or flats within the limits of the proposed improvement.

The act of July 5, 1884, contained no proviso of this kind, but that of August 5, 1886, contained the following proviso:

Provided, That no part of the sum hereby appropriated shall be expended upon or with reference to any place in respect to which the title of the United States is in doubt, or in respect to which any claim adverse to the United States has been made.

The two subsequent river and harbor acts contained no provisos.

The following special act was passed August 5, 1886:

[Public—No. 181.]

AN ACT to provide for protecting the interests of the United States in the Potomac River Flats, in the District of Columbia.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the duty of the Attorney-General of the United States to institute, as soon as may be, in the supreme court of the District of Columbia, a suit against all persons and corporations who may have or pretend to have any right, title, claim, or interest in any part of the land or water in the District of Columbia within the limits of the city of Washington, or exterior to said limits and in front thereof toward the channel of the Potomac River, and composing any part of the land or water affected by the improvements of the Potomac River or its flats in charge of the Secretary of War, for the purpose of establishing and making clear the right of the United States thereto.

SEC. 2. That the suit mentioned in the preceding section shall be in the nature of a bill in equity, and there shall be made parties defendant thereto all persons and corporations known to set up or assert any claim or right to or in the land or water in said first section mentioned, and against all other persons and corporations who may claim to have any such right, title, or interest. On the filing of said bill process shall issue and be served, according to the ordinary course of said court, upon all persons and corporations within the jurisdiction of said court; and public notice shall be given, by advertisement in two newspapers published in the city of Washington, for three weeks successively, of the pendency of said suit, and citing all persons and corporations interested in the subject-matter of said suit, or in the land or water in this act mentioned, to appear, at a day named in such notice, in said court, to answer the said bill and set forth and maintain any right, title, interest, or claim that any person or corporation may have in the premises; and the court may order such further notice as it shall think fit to any party in interest.

SEC. 3. That the said cause shall then proceed with all practicable expedition to a final determination by said court of all rights drawn in question therein; and the said court shall have full power and jurisdiction by its decree to determine every question of right, title, interest, or claim arising in the premises, and to vacate, annul, set aside, or confirm any claim of any character arising or set forth in the premises; and its decree shall be final and conclusive upon all persons and corporations parties to the suit, or who shall fail, after public notice as hereinbefore in this act provided, to appear in said court and litigate his, her, or its claim, and they shall be deemed forever barred from setting up or maintaining any right, title, interest, or claim in the premises.

SEC. 4. That if, on the final hearing of said cause, the said supreme court of the District of Columbia shall be of opinion that there exists any right, title, or interest in the land or water in this act mentioned in any person or corporation adverse to the complete and paramount right of the United States, the said court shall forthwith and in a summary way proceed to ascertain the value of any such right, title, interest, or claim, exclusive of the value of any improvement to the property covered by such right, title, or interest made by or under the authority of the United States, and report thereof shall be made to Congress.

SEC. 5. That from the final decree of the supreme court of the District of Columbia, and every part thereof, in the premises, an appeal shall be allowed to the United States, or to any other party in the cause complaining of such decree, to the Supreme

Court of the United States, which last-mentioned court shall have full power and jurisdiction to hear, try, and determine the said matter, and every part thereof, and to make final decree in the premises; and the said cause shall, on motion of the Attorney-General of the United States, be advanced to the earliest practicable hearing: *Provided,* That no payment under any such judgment shall be made unless hereafter authorized by Congress.

SEC. 6. That until the final decision of the matters hereinbefore in this act mentioned shall have been had, no moneys appropriated for the improvement of the Potomac River within the District of Columbia, the establishment of harbor lines in the District of Columbia, and the raising of the Flats therein, shall be expended otherwise than upon property in respect of which there is no claim adverse to the title of the United States or for the improvement of navigation in the said river.

Approved August 5, 1886.

In accordance with the provisions of the above act a bill of complaint and answers were filed November 26, 1886, in the supreme court of the District of Columbia, holding a special term in equity.

This suit has now been pending nearly six years, but since the passage of the river and harbor act of August 5, 1886, and of the special act of the same date, the work of reclamation and filling in has been confined to the portion of the flats below the limit of the marsh known as "Kidwell's Meadows."

WORK DONE AND RESULTS OBTAINED.

At the close of the fiscal year ending June 30, 1891, the expenditures aggregated $1,626,821.37, and the following work had been accomplished: The Virginia Channel above Long Bridge had been deepened to 20 feet at low tide for a width of from 400 to 550 feet, a part of which has since filled up and been redredged. The same channel below Long Bridge had been dredged to a depth of 20 feet and a width of about 350 feet. This part of the Virginia Channel has maintained itself to the full depth originally dredged or has deepened. The Washington Channel had been dredged to a depth of 20 feet for a width of 350 feet throughout its entire length, and to a depth of 12 feet from the 20-foot channel nearly to the easterly margin of the fill, from the lower end of the reclaimed area up as far as the Seventh Street Wharf. This channel has for the most part maintained itself, though some filling occurred during the freshet of June, 1889.

The junction of the Virginia and Washington channels had been dredged to depths of 20 feet, 15 feet, and 12 feet. The greater part of the Tidal Reservoir had been dredged to a depth of 8 feet. All the material dredged from the river had been deposited on the flats, and of the 12,000,000 cubic yards estimated to be required about 8,566,000 had been deposited. The entire area of the flats, about 621 acres, had been outlined, and practically the entire area to be reclaimed had been raised above overflow at ordinary high tide.

The riprap foundation for the sea wall had been put in place around the entire river front of the reclaimed area and the margin of the tidal reservoir. The construction of the sea wall for the protection of the margin of the fill from erosion by waves and the action of the currents, had been commenced and about 5,100 linear feet of wall constructed. The construction of a training dike on the westerly side of the Virginia Channel above the Long Bridge had been commenced and was about one-half completed. This dike is intended to maintain the dredged channel and prevent the re-formation of the bar at this locality. The outlet gates of the tidal reservoir at the head of the Washington Channel had been completed with the exception of the coping.

WORK OF THE FISCAL YEAR ENDING JUNE 30, 1892.

During the fiscal year ending June 30, 1892, the expenditures have been $171,120.

The work done during the fiscal year has been as follows:

Sea wall.—On June 30, 1891, the construction of the sea wall on the river front of the reclaimed area was in progress. The wall is a dry stone wall built on a riprap foundation. The wall is 6 feet high, 4 feet thick at the base, and 2.5 feet thick at the top. The stone was purchased under a contract with W. H. Mohler, at $1.70 per cubic yard, supplemented by purchases in open market at the same price when deliveries by the contractor fell below the contract rate. The wall was laid up by hired labor, this method being the most advantageous and economical for this part of the work. Eight thousand seven hundred and forty linear feet of wall were constructed during the year. The wall is now completed along the greater part of the river front of Sections I and II, above the Long Bridge, and along the Washington Channel front of Section III, from a point opposite the foot of Seventh street to the lower end of the section. Operations on the wall were suspended for the season on December 23, 1891, and, for want of available funds, have not since been resumed. The contract of Mr. Mohler was closed.

Virginia Channel.—On July 7, 1891, a contract was entered into with Frank C. Somers, of Camden, N. J., for dredging in the Virginia Channel above the Long Bridge, at 15.5 cents per cubic yard. Proposals for this work were opened June 25, 1891, and an abstract of the same published in the annual report of June 30, 1891. This dredging was intended to restore 20-foot navigation in the Virginia Channel above the Long Bridge, where, under the action of the freshet of 1889 and subsequent smaller freshets, the bar had again formed. Work under the contract was commenced September 1, 1891, with one hydraulic dredge. In November and December, 1891, a second hydraulic dredge was used on the work. The material found was chiefly mud at the upper end of the channel and sand near the middle and lower end. It was deposited on Section I near the Sewer Canal, and on Section II, between the Sewer Canal and the Reservoir Inlet. Work was suspended on January 11, 1892, by reason of apprehended danger from ice, but was resumed on February 23, 1892. On June 30, 1892, a channel 6,000 feet long, 20 feet deep, and 200 feet wide had been dredged through the bar, and the widening of this channel to 250 feet in width was in progress. The amount of dredging under the contract to June 30, 1892, was 352,027 cubic yards.

Work on the training dike on the westerly side of the Virginia Channel was continued, and the earthern embankment forming the upper 2,400 feet of the dike was completed by means of a hired dredge. The height of the embankment is from 7 to 9 feet above low tide. Below the embankment for a distance of 2,500 feet in water from 1 to 9.5 feet in depth there is a footing of riprap stone in place, but the embankment behind it has not yet been formed.

A hired dredge was employed as needed to raise the embankments along the Virginia channel above the Long Bridge preliminary to the construction of the sea wall.

Washington Channel.—On June 30, 1891, dredging in the Washington Channel was in progress under the contract of the Alabama Dredging and Jetty Company, dated December 17, 1890. The contract provided for dredging a part of the area between the 20-foot channel and the easterly margin of Section III to a depth of 12 feet at low tide, and de-

positing the material on Section III below the Long Bridge to a grade which should not exceed about 12 feet above low tide at the middle line of Section III, and about 6 feet above low tide at the margin of the section. The contract price was 14.5 cents per cubic yard measured in place in the river by cross sections taken before and after dredging. The material was mud. The contractors used ordinary clam-shell dredges for dredging, depositing the material on shore by means of the Riker pump and chutes. In a mistaken attempt to economize in the cost of the work, the contractors attempted to deposit all of the material to be dredged under the contract from a single position of the pump opposite the center of the basin in which the deposit was to be made, and which was about 2,500 feet long by about 900 feet wide. A single chute, with several branches was used to convey the material and distribute it over the basin. The maximum height of the chute at the discharge of the pump was 52 feet above low tide, while the other end was about 15 feet above low tide. It was found, however, that the material did not "flow" as readily or as far as had been expected, and the flow was further retarded by frequent delays from the breaking down of the dredges and the pump and in building new chutes, during which cessation of work the material dried out and stopped moving. Great difficulty was experienced in getting the contractors to build the branches and extensions of the chutes required for the deposition of the material in accordance with the terms of the contract. Owing to these various causes the height of the fill increased, and on August 31, 1891, its maximum height was 15 feet above low tide. The attention of the contractors' superintendent was repeatedly called to the fact that the filling was above the specified grade, and he was directed to build other chutes and take measures for the deposition of the material in accordance with the contract. He was of the opinion, however, that the material would settle down and dry out so as to reach substantially the required grade. The original chute was raised and another branch built, but a large part of the deposited material was still above grade. Meanwhile the time for the completion of the contract expired on October 1, 1891, and an extension was granted until February 1, 1892. On the last-named date, of the 500,000 cubic yards to be dredged under the contract, 379,195 cubic yards had been excavated. A further extension was granted until April 1, 1892.

On February 1, 1892, the Riker pump broke down, and as a considerable delay would be necessary for its repair, the contractors decided to abandon this method of working and adopt the hydraulic method, using a dredge with a rotary pump and discharging the material by means of pipes. Levels taken over the fill while it was frozen showed the maximum height to be about 18 feet above low tide. On February 10, 1892, a letter was addressed to the contractors calling their attention to this fact, to the large amount of material above grade, and to the requirements of the contract as to the grade line. In February a small amount of material was dredged near the Arsenal and dumped in a convenient position for excavation by a hydraulic dredge. In February and March both grapple dredges were withdrawn from the work. On March 8, 1892, an hydraulic dredge was brought to the work and after considerable fitting up a trial of the dredge was made on March 16. The cutting apparatus did not appear to be adapted to the work, however, and but little material was dredged. The machine was run parts of several days, and about 1,000 cubic yards excavated. Work was suspended March 26, 1892, and has not since been resumed. On March 29, 1892, the contractors requested a third extension of time

for sixty days, which was granted. On April 30, 1892, the Alabama Dredging and Jetty Company executed a power of attorney authorizing C. Amory Stevens of New York to receipt for all moneys due under their contract, except the reserved percentages. This power of attorney was approved by the Second Comptroller. No work was done under the contract during the third extended term of the same. On May 17, 1892, the contractors applied for a fourth extension of the contract until July 15, 1892. This extension was granted with the understanding that the work was to be immediately resumed and energetically prosecuted. No work has yet been done during the fourth extension of the contract. Levels taken over the fill in June, 1892, showed the maximum height to be 17 feet above low tide, and the amount of material above grade 94,790 cubic yards.

In August, 1891, a hired dredge was employed in building up the embankment on the Washington Channel front of Section III, preliminary to the construction of the sea wall.

Anacostia River.—The act of September 19, 1890, provided that $20,000 of the appropriation of $280,000 for improving the Potomac River should be available for expenditure on the channel in the Anacostia River between the navy-yard and Giesboro Point. Under this provision a contract was made with Frank C. Somers, of Camden, N. J., under date of June 10, 1891, to widen and deepen the channel, the width to be about 200 feet and the depth 20 feet at low tide, the excavated material to be deposited in embankment on the flats, with the object of controlling the currents and reducing the deposit in the channel. The contract price was 17.9 cents per cubic yard, scow measurement. Work under this contract was commenced November 13, 1891. Two clamshell dredges were at first employed in dredging a trench and forming an embankment between Poplar Point and the Insane Asylum Channel, the trench to be used for the deposit of the material to be dredged from the channel. On December 11, 1891, one of these dredges commenced work in the channel near the foot of South Capitol street. On December 31, 1891, the time for the completion of this contract was extended to May 15, 1892. The work proceeded during the winter with but four days' interruption from ice. The dredging near the foot of South Capitol street was completed March 16, 1892. The dredge was then moved to the mouth of the river off Greenleaf or Arsenal Point. Here the channel was widened and deepened as far as the available funds would permit. The excavated material was soft mud, so soft, in fact, that it was found impossible to raise the embankment to a height of more than from 3.5 to 4 feet above low tide. The channel dredging was concluded April 26, 1892, and the work on the embankment on May 24, 1892. The total amount of channel dredging under this contract was 90,217 cubic yards.

Reservoir outlet.—On June 30, 1891, the coping for the reservoir outlet and wing walls had been ordered and was being cut in Maine. The coping was delivered in September, 1891, and the setting of stone commenced. This work was continued until December, 1891, when it was completed. The addition of the railing only remains to complete the structure. One pair of gates was broken by an obstructing log or pilehead, during the reconstruction of the Long Bridge, so that it was necessary to rebuild them.

LONG BRIDGE.

On July 14, 1891, the Baltimore and Potomac Railroad Company submitted to the Secretary of War plans for the reconstruction of the Long Bridge across the Washington Channel. The plan adopted for the improvement of the Potomac River provides for filling up the flats at the head of the Washington Channel so that the greater part of the Long Bridge across this channel could be dispensed with upon the completion of the filling. Spans require to be maintained, however, across the opening below the reservoir outlet, so as to afford passage for the water flowing from the tidal reservoir into the Washington Channel. The existing wooden spans of this part of the Long Bridge were in bad condition, and could not be used much longer for the heavy traffic passing over them. The Baltimore and Potomac Railroad Company therefore proposed to rebuild so much of the bridge as crosses the waterway of the reservoir outlet, substituting plate girders for the wooden truss, and to fill in with earth under the remaining spans, the trusses of which were then to be removed.

The plans provide for the construction of a new masonry pier in the center of the opening and two new abutments of masonry located so that their up-stream ends are met by the continuation of the wing walls of the reservoir outlet. There are two plate girder spans each 79′ 9″ in the clear under the coping. The girders are 8 feet in depth, with their lower flanges at an elevation of 12 feet above low tide. The foundations were to be 6.5 feet below low tide and the average depth of water between the piers and abutments was to be 8 feet at low tide.

The plans were referred to this office for report, and a report was submitted on July 20, 1891, recommending their approval. On July 28, 1891, the plans were approved by the Secretary of War. The Baltimore and Potomac Railroad Company at once entered upon the work of reconstruction, and at the close of the year the bridge proper was practically completed. On filling the approaches with earth, however, a decided and serious settlement and movement of the abutments were developed, which were most marked in the southwest abutment, which settled no less than 18 inches, while the downstream wing moved forward about 4 feet. This movement was no doubt due to the pressure of the earth filling upon the thick stratum of soft mud underlying the river bed at this locality, and which extends to a depth of about 74 feet below low tide. In order to check the movement the company have removed the earth immediately behind the abutments and driven piles close together in the river bed in the span opening. It has been necessary to support the ends of the girders in front of the south abutment by trestles, and it is understood that the company propose to rebuild this abutment. The work can not yet therefore be reported as complete.

The project for the improvement of the Potomac River contemplated the rebuilding of Long Bridge across the Virginia Channel also. As the improvement progresses, the necessity for this becomes more and more urgent. The piers of the bridge are more numerous than are necessary in a structure built according to modern plans, and are in a direction oblique to the flow of freshets. Furthermore they are surrounded by great quantities of riprap stone which has been deposited around them from time to time to protect them. It is estimated that below low-tide level the natural discharge area of the Potomac River at Long Bridge is reduced over 30 per cent by the piers and their foundations as they exist to-day.

Long Bridge, on account of its faulty construction, remains a constant

menace to the interests on the river front above it, and also to the work of improvement of the flats, upon which the Government has already spent a large sum. In the event of a freshet occurring while the river is full of ice, the most serious results are to be apprehended, and such a contingency is not at all unlikely. Should an ice gorge form at Long Bridge, it would back up the waters of the river and overflow portions of the city front and, through the sewers above the bridge, such of the lower parts of the city as are drained by them.

During the freshet of June, 1889, the water reached a height at Long Bridge of about 13 feet above low tide. The street surface at Fourteenth and B streets NW. is about 8 feet above low tide, and during the freshet referred to the water was about 5 feet deep in the street at that locality. Great damage was done by the freshet of 1889, but greater damage may occur from a freshet of lesser magnitude, if accompanied by an ice gorge. The bridge should be rebuilt as recommended by the Board of Engineers.

Amount expended on the improvement up to and including June 30, 1892	$1,797,941.37
Amount required to complete the improvement in addition to amount on hand	681,365.00
Annual cost of preserving and maintaining (estimated)	5,000.00

Washington City is in the collection district of Georgetown, D. C.; nearest lighthouse, Jones Point, Virginia.

Money statement.

July 1, 1891, balance unexpended		$228,178.63
June 30, 1892, amount expended during fiscal year		171,120.00
July 1, 1892, balance unexpended		57,058.63
July 1, 1892, outstanding liabilities	$703.00	
July 1, 1892, amount covered by uncompleted contracts	41,183.00	
		41,886.00
July 1, 1892, balance available		15,172.63
Amount appropriated by act approved July 13, 1892		200,000.00
Amount available for fiscal year ending June 30, 1893		215,172.63
Amount (estimated) required for completion of existing project		681,365.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		681,365.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[Furnished by Mr. J. W. Averill, Washington, D. C.]

Receipts and shipments.

Calendar year.	Coal.	Ice.	Lumber.	Sand.	Wood.	Miscellaneous.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1887	264,947	120,237	37,044	50,000	52,419	94,325	618,972
1888	240,836	108,421	45,101	50,000	33,040	104,177	581,575
1889	92,511	115,506	41,407	75,000	35,351	128,905	488,680
1890	72,089	135,552	69,604	75,000	48,457	118,994	519,696
1891	114,913	123,107	50,106	60,000	48,457	154,636	551,219

The falling off in coal is due to the destruction of the Chesapeake and Ohio Canal.

Number of vessels of various classes arriving and departing.

Calendar year.	Steamers drawing from 5 to 15 feet, 100 to 400 tons.	Vessels drawing from 10 to 20 feet, 800 to 1,700 tons.	Vessels drawing from 4 to 10 feet, 30 to 800 tons.	Barges drawing from 4 to 10 feet, 100 to 300 tons.
1887	970	578	2,149	993
1888	710	525	1,588	2,821
1889	675	455	1,563	929
1890	696	491	1,572	286
1891	980	445	1,854	862

Ferry and local passenger steamers are not included in the above. No new lines of transportation were established during 1891.

J 2.

IMPROVEMENT OF POTOMAC RIVER AT MOUNT VERNON, VIRGINIA.

ORIGINAL CONDITION.

Mount Vernon is situated on the Virginia shore of the Potomac River, 14.5 miles below Washington, D. C. The only convenient means of access for visitors is by the steamer which runs between Washington and Mount Vernon, landing at the wharf on the Mount Vernon estate. Between this wharf and the navigation channel of the Potomac River, a distance of about 1,900 feet, are flats on which the depth was originally but 4 feet at low tide. Great difficulty was often experienced, in consequence, in making landings even with the light-draft steamer formerly in use, and during low tides, caused by northwest winds, passengers were frequently obliged to land in boats.

PLAN OF IMPROVEMENT.

The original project provided for the dredging of a channel 150 feet wide and from 6 to 7 feet deep at low tide, between the main channel of the Potomac River and the Mount Vernon wharf, with a turning basin at the wharf having a radius of 150 feet. The estimated cost of this work was $14,000. In 1888 the project was amended so as to provide for a channel 200 feet wide and from 9 to 10 feet deep, with a turning basin of 200 feet radius. The revised estimate for the total cost of the amended project was $26,000.

WORK DONE AND RESULTS OBTAINED.

Under appropriations of March 3, 1879, amounting to $4,000, June 14, 1880, amounting to $3,000, and March 3, 1881, amounting to $1,500, a channel 145 feet wide and from 7 to 9 feet deep was dredged through the flats. Work under the last-named appropriation was closed September 15, 1882. Operations were then suspended for want of funds until August 11, 1888, when $6,000 was appropriated. In the mean time the channel had filled in considerably. The appropriation of August 11, 1888, was applied to deepening a part of the existing channel to a depth of from 9 to 12 feet, and to the enlargement of the turning basin to a width of 360 feet.

The river and harbor act, approved September 19, 1890, appropriated $2,500 to complete the work, and subsequent operations were conducted with this end in view. Under this appropriation dredging by contract (see last Annual Report) was commenced March 28, 1891, and completed May 19, 1891. The dredging consisted in widening the channel on the westerly side, and in enlarging the turning basin, the depth made being 8 feet at low tide. Upon the completion of the work the channel was 155 feet wide, and the depth from 8 to 10 feet at low tide. The turning basin had a radius of 180 feet, with a like depth of from 8 to 10 feet. The amount of dredging was 12,846 cubic yards, which was removed in scows.

FUTURE OPERATIONS.

The channel has now sufficient dimensions for navigation, and no further work is recommended.

APPROPRIATIONS.

The following appropriations have been made:

March 3, 1879	$4,000
June 14, 1880	3,000
March 3, 1881	1,500
August 11, 1888	6,000
September 19, 1890	2,500
	17,000

Mount Vernon is in the collection district of Alexandria, which is also the nearest port of entry. The nearest light-house is at Fort Washington, Md.

Money statement.

July 1, 1891, balance unexpended	$502.86
June 30, 1892, amount expended during fiscal year	502.86

COMMERCIAL STATISTICS.

The traffic is almost entirely a passenger one, the freighting being only the incidental local trade. The improvement has permitted the use of larger steamboats, which carried to Mount Vernon during the calendar year 1891 about 35,000 people.

J 3.

IMPROVEMENT OF OCCOQUAN CREEK, VIRGINIA.

ORIGINAL CONDITION.

Occoquan Creek is a tributary of the Potomac River, which it enters about 25 miles below Washington, D. C. The stream is navigable from its mouth at Sandy Point to the town of Occoquan, a distance of 4 miles. Navigation was obstructed by four bars which were improved between 1873 and 1880 by dredging and dike construction, so as to secure a navigable depth of about 6 feet at low tide. Four appropria-

tions were made from 1873 to 1878, amounting to $25,000, and in 1880 the improvement was regarded as completed.

In compliance with the provisions of the river and harbor act of August 11, 1888, a new survey of the creek was made in 1889 by Mr. S. T. Abert, United States agent. The condition of the several bars at that date was as follows:

Lower Mud, about 3.5 miles below Occoquan. This bar had a least depth of about 3 feet and a length of about 4,000 feet. The former dredged channel was found to have filled in.

Upper Mud, about 2.25 miles below Occoquan. This bar is about 2,000 feet long. The channel dredged in 1874–'75 was found to have maintained its original dimensions, the width being about 50 feet and the depth from 5 to 6 feet.

Sand Bar, about half a mile below Occoquan. The channel formerly dredged here had filled in, the least depth being 4.2 feet.

Occoquan Bar, a sand bar opposite Occoquan. This is a short bar, with a least depth of 4 feet, the dredged channel having filled in.

PLAN OF IMPROVEMENT.

The depth desired for navigation was 6 feet at low tide. Mr. Abert proposed in his report upon the survey to secure this depth by dredging channels 8 feet deep and from 100 to 150 feet wide, and by the construction of dikes at an estimated cost of $91,250. (Report of Chief of Engineers, 1890, pages 1089–1096.) On September 19, 1890, an appropriation of $10,000 was made for the new improvement, for which the following project was approved December 5, 1890:

Lower Mud.—A channel 6 feet deep to be dredged, the "upper section" for about 2,500 feet below Taylor's Point, to be 100 feet wide, the material to be deposited on the west side of the channel, and the remainder of channel or "lower section" to be 150 feet wide, the material to be removed in scows.

Upper Mud.—A channel 100 feet wide and 6 feet deep to be dredged, the material to be deposited on the east side of the channel, and the embankment so formed connected with the left bank by a dike.

Sand Bar.—A channel 100 feet wide and 6 feet deep to be dredged and sheet-pile dikes constructed to maintain the dredged channel.

Occoquan Bar.—A channel 100 feet wide and 6 feet deep to be dredged, and a sheet-pile dike constructed to maintain the depth.

The estimated cost of this project was $45,000.

WORK DONE AND RESULTS OBTAINED.

Under the appropriation of $10,000 made September 19, 1890, a contract was entered into with D. McConville, of Washington, D. C., for dredging a channel through the Lower Mud at the following prices:

Upper section.—Material dredged and deposited on the sides of the channel, 10.5 cents per cubic yard, measured in place.

Lower section.—Material dredged and removed in scows, 14.5 cents per cubic yard, measured in scows.

The contract was entered into March 23, 1891. Dredging was commenced May 8, 1891, and was in progress at the close of the last fiscal year, June 30, 1891. At this date the contractor was engaged in dredging the upper section of the channel, the material being deposited on the right side of the channel by means of an endless chain dredge designed for this kind of work. The upper section of the channel was

completed July 31, 1891, the width being 100 feet, the depth 6 feet at low tide, and the total length 3,720 feet. The total amount of excavation was 36,640 cubic yards. The center of the embankment formed by the dredged material was about 105 feet from the right edge of the channel, and the foot of the slope was from 40 to 50 feet from the right edge of the channel.

The dredging of the lower section of the channel required the use of scows. The contractor was not provided with scows, and a delay of three weeks occurred, in consequence, until August 21, 1891, when a clam-shell dredge provided with scows commenced dredging the lower section. This section was completed September 5, 1891, the amount of dredging being 8,567 cubic yards. The length of the section was 870 feet, the width 150 feet, and the depth 6 feet. The excavated material was deposited in a cove on the east shore of Occoquan Bay inside of High Point. The lower section of the channel was dredged 150 feet wide in order to obviate as far as possible the injurious action of cross-tidal currents to and from Belmont Bay, which it is believed will tend to fill in and decrease the width of this part of the channel.

Upon the completion of the channel through the Lower Mud in accordance with the project, there remained a balance of the appropriation of September 19, 1890, available for other work. An examination of the locality indicated that Occoquan Bar, opposite and immediately below the town of Occoquan, was then the next in order as an obstruction to navigation. The approved project provides for dredging a channel and also for the construction of a dike at this bar to maintain the channel secured by dredging. The available funds were, however, insufficient for both classes of work, and as it was evident that the dredging would be of the greatest public benefit the funds were applied to this part of the project.

Proposals for dredging a channel through this bar were invited by public advertisement, and the following received September 21, 1891:

Name and address of bidder.	Price per cubic yard.	Estimated amount.
	Cents.	
Fred L. Somers, Philadelphia, Pa.	22	$1,980

The contract was awarded to Fred. L. Somers, of Philadelphia, Pa., and entered into October 16, 1891.

Dredging was commenced at Occoquan Bar, under this contract, on December 9, 1891, but proceeded slowly, as the contractor's scows were not adapted to the work. On January 5, 1892, the contractor suspended work, stating that he was apprehensive of injury to his plant from ice. Operations were resumed March 4, 1892, and continued until May 16, 1892, when the work was closed—all the available funds having been applied thereto. The upper section of this channel was dredged to a width of 100 feet and the lower section to a width of 70 feet, the depth of both sections being 8 feet at low tide. The depth was made 8 feet to provide for the filling from freshets which may be anticipated until the dike is built. The amount of dredging under this contract was 12,399 cubic yards. The dredged material was removed in scows and deposited chiefly below the railroad bridge on the upper end of the Belmont Bay Flats.

FUTURE OPERATIONS.

The work remaining to be done under the project is the improvement of the Upper Mud, the Sand Bar, and the completion of the improvement at Occoquan Bar, the estimated cost being $30,000.

APPROPRIATION.

The following appropriations have been made for the new project:

September 19, 1890	$10,000
July 13, 1892	5,000
Total	15,000

Occoquan Creek is in the collection district of Alexandria, which is also the nearest port of entry. The nearest light-house is at Fort Washington, Md.

Money statement.

July 1, 1891, balance unexpended	$8,394.99
June 30, 1892, amount expended during fiscal year	8,188.98
July 1, 1892, balance unexpended	206.01
July 1, 1892, outstanding liabilities	8.00
July 1, 1892, balance available	198.01
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,198.01
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished by Messrs. L. Ledman and Tyson Janney, Occoquan, Va.]

Receipts and shipments for calendar year 1891.

	Tons.
Coal	100
Grain	60
Lumber	600
Wood	3,500
Railroad ties	3,600
Miscellaneous	345
Total	8,205

It is reported that freight rates have been cheapened. No new lines of transportation were established in 1891.

J 4.

IMPROVEMENT OF AQUIA CREEK, VIRGINIA.

ORIGINAL CONDITION.

Aquia Creek is a tributary of the Potomac River, which it enters 41 miles below Washington, D. C. The stream is navigable to Wharton

Landing, about 7.25 miles above the mouth. The upper part of the creek has a well-defined channel, with a width of from 60 to 200 feet, while the depth was originally from 2 to 17 feet. At a point called the Narrows, about 4.5 miles above the mouth, the stream suddenly expands into a wide bay, from 1,000 to 6,000 feet wide, forming a continuous shoal, on which the depth ranged generally from 2 to 4 feet, increasing near the mouth to about 7 feet. About 3 miles above the mouth the creek is crossed by a trestle bridge of the Richmond, Fredericksburg and Potomac Railroad. The bridge is provided with a draw 28 feet wide.

Between 1872 and 1878 $10,000 was appropriated by Congress and expended in dredging a channel through shoal portions of the creek, between Davis Point (about one-third of a mile below the Railroad Bridge) and Wharton Landing, the channel being from 40 to 50 feet wide, and from 4 to 5 feet deep at low tide.

A new survey of the creek was authorized by the river and harbor act of August 11, 1888, and made in 1889, under the direction of Mr. S. T. Abert, United States agent. The channel formerly dredged was found to be about 40 feet wide, and from 4 to 5 feet deep between the railroad bridge and the Narrows. Below the railroad bridge and in the upper part of the creek, near Wharton Landing, it had filled in. Dent Landing, about three-quarters of a mile below Wharton Landing, was regarded as the highest point to which navigation could be maintained except at great expense. The obstructions to navigation below Dent Landing were the long shoal of soft mud between the mouth and the Narrows, on which the depth ranged from 2 to 4 feet; a short bar at the mouth of Austen Creek with a ruling depth of 4 feet; and a wreck at Coal Landing.

PLAN OF IMPROVEMENT.

In the report on the survey (Report of Chief of Engineers, 1890, pages 1096–1103), Mr. Abert proposed a channel 150 feet wide and 8 feet deep between the mouth and the Narrows, and a channel 80 feet wide and 8 feet deep through the bar at the mouth of Austen Creek. The estimated cost of the improvement was $101,278.

On September 19, 1890, Congress appropriated $10,000 for this work. Upon further examination of this creek in 1890 the character of its navigation and the amount of its trade did not seem to warrant so large an expenditure as was proposed in Mr. Abert's report. Six-foot navigation was regarded as sufficient to give all the relief needed to navigation at the present time, leaving the subject of greater depth for future action, if trade were developed by this improvement.

The following project for the work was therefore adopted December 4, 1890: A channel 80 feet wide and 6 feet deep to be dredged between the mouth and the Narrows, at an estimated cost of $40,000, the material dredged below the railroad bridge to be removed in scows, and that above the bridge for the most part to be deposited on the sides of the channel. The proposed work above the Narrows was omitted.

WORK DONE AND RESULTS OBTAINED.

Under the appropriation of September 19, 1890, a contract was entered into on May 28, 1891, with Frank C. Somers, of Philadelphia, Pa., for dredging that part of the channel below the railroad bridge at 12.5 cents per cubic yard. Work was commenced June 11, 1891, and at

the close of the last fiscal year, June 30, 1891, was still in progress. At that date the channel had been dredged to the full width of 80 feet from the 6-foot curve near Thorny Point for a distance of 2,670 feet, the depth being 6 feet at low tide.

Dredging operations were continued with favorable progress through July and until August 19, 1891, when a channel 80 feet wide and 6 feet deep was completed to the draw of the Richmond, Fredericksburg and Potomac Railroad bridge. The contract was then closed.

The total length of the channel from the 6-foot curve near Thorny Point to the railroad bridge is 12,280 feet. In this distance it was unnecessary to dredge for a length of 3,400 feet, as a depth of 6 feet was found. The channel is thus divided into two sections, the lower being 2,740 feet in length, and the upper, near the bridge, 6,140 feet in length. The material dredged was soft mud. It was removed in scows and deposited in the Potomac River off Brents Point. The total amount of dredging under the contract was 60,438 cubic yards.

FUTURE OPERATIONS.

The work remaining to complete the project for this improvement is the dredging of the channel between the railroad bridge and the Narrows, a distance of about 6,500 feet. The draw through the railroad bridge is but 28 feet wide. This width is insufficient for the passage of the dredges now usually employed on river and harbor work. A dredge such as would be required for the proper and economical execution of the work above the bridge would be about 35 feet wide, and to permit the passage of such a dredge the draw should be widened to at least 40 feet. The attention of the Richmond, Fredericksburg and Potomac Railroad was called to this matter on March 24, 1891, and they were requested to increase the width of the draw when the road was double tracked—a work which it was understood was about to be commenced by the company at that time.

APPROPRIATION.

The following appropriations have been made for the new work:

September 19, 1890	$10,000
July 13, 1892	5,000
Total	15,000

Aquia Creek is in the collection district of Alexandria, which is the nearest port of entry. The nearest light-house is at Upper Cedar Point, Md.

Money statement.

July 1, 1891, balance unexpended	$9,500.00
June 30, 1892, amount expended during fiscal year	8,889.05
July 1, 1892, balance unexpended	610.95
July 1, 1892, outstanding liabilities	115.00
July 1, 1892, balance available	495.95
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,495.95
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Efforts were made to obtain commercial statistics, but the information regarding receipts and shipments was so indefinite that it could not be used.

Arrivals and departures of vessels.

Steam tugs drawing less than 5 feet	10
Sailing vessels drawing less than 4.5 feet	165
Barges, flatboats, etc	20

J 5.

IMPROVEMENT OF HARBOR AT BRETON BAY, LEONARDTOWN, MARYLAND.

ORIGINAL CONDITION.

Breton Bay is a tidal estuary of the Potomac River, which it enters 82 miles below Washington, D. C. The bay is about 6 miles long and well landlocked. Fifteen feet of water can be carried up the bay for a distance of 4 miles, and 9 feet for a distance of 5 miles. In 1874 the navigation was obstructed by a shoal at the head of the bay, extending from the 9-foot curve to the Leonardtown Wharf, a distance of about 1 mile, the least depth on the shoal being 5 feet at low tide. The material composing the shoal was soft mud.

PLAN OF IMPROVEMENT.

The original project, adopted in 1878, provided for dredging a channel 150 feet wide and 9 feet deep from the 9-foot curve in Breton Bay to the Leonardtown Wharf, with a turning basin for steamboats at the wharf 400 feet wide and 600 feet long, at an estimated cost of $30,000. In 1885 the project was amended so as to provide for a channel 200 feet wide and 10 feet deep, the turning basin to be 800 feet long and 400 feet wide. The estimated cost of the amended project was $49,000.

In 1890 the original project was resumed, a width of 150 feet and a depth of 9 feet being deemed sufficient to furnish all the facilities needed by navigation at the present time.

WORK DONE AND RESULTS OBTAINED.

From June 18, 1878, to August 11, 1888, eight appropriations were made, ranging from $3,000 to $6,500, and aggregating $32,500. This sum was applied to dredging 185,429 cubic yards of material at rates ranging from 10 to 18 cents per cubic yard. On March 2, 1889, when work was closed under the appropriation of August 11, 1888, the basin at the upper end of the channel was 645 feet long and 370 feet wide. From the lower end of the basin the channel was 150 feet wide for a distance of 1,870 feet, and for a further distance of 1,380 feet around the turn at Buzzards Point the width varied from 185 to 230 feet. The depths varied from 8.5 to 14.6 feet. No dredging had been done between the lower end of the turn at Buzzards Point and the 9-foot curve in the bay.

The river and harbor act approved September 19, 1890, appropriated

$5,000 for this work, which sum was sufficient to complete the work called for by the original project. A contract was entered into March 9, 1891, with the Baltimore Dredging Company of Baltimore, Md., for dredging in the channel at 12.5 cents per cubic yard. Dredging was commenced June 15, 1891, and at the close of the fiscal year ending June 30, 1891, was still in progress. Operations, under the contract, were continued during July and the greater part of August, 1891. The plant consisted of one dipper dredge, one tug, and four scows. Good progress was made with the work, and it was completed August 25, 1891. The total amount of dredging under the contract was 28,800 cubic yards. The excavated material was removed in scows and deposited in Breton Bay, about 2.25 miles below the wharf at Leonardtown. The average daily work of the dredge was about 500 cubic yards. The channel, as completed, is 9 feet deep at low tide, extending from the 9-foot curve in Breton Bay to the Leonardtown wharf. The width of the channel is 150 feet, except at the turn off Buzzards Point, where the width has been made 320 feet to facilitate the turning of steamers, the two reaches of the channel making an angle of nearly 90° with each other. The basin at the Leonardtown wharf is 9 feet deep, 370 feet wide, and 600 feet long. For a further length of 335 feet the width gradually decreases to 150 feet at the junction of the channel.

FUTURE OPERATIONS.

The existing project has been completed with the funds appropriated, and will afford all the facilities which the navigation requires at the present time. Should the trade increase in the future the question of increased dimensions of channel will be worthy of consideration, but at present no further appropriations are recommended.

APPROPRIATIONS.

The following appropriations have been made:

June 18, 1878	$5,000
March 3, 1879	4,000
June 14, 1880	3,000
March 3, 1881	3,000
August 2, 1882	5,000
July 4, 1884	3,000
August 5, 1886	6,500
August 11, 1888	3,000
September 19, 1890	5,000
Total	37,500

The work is in the collection district of Annapolis. The nearest light-house is at Blackistone Island.

Money statement.

July 1, 1891, balance unexpended	$4,482.21
June 30, 1892, amount expended during fiscal year	4,417.21
July 1, 1892, balance unexpended	65.00
July 1, 1892, outstanding liabilities	65.00

COMMERCIAL STATISTICS.

No statistics for the year 1891 could be obtained.

J 6.

IMPROVEMENT OF NOMINI CREEK, VIRGINIA.

ORIGINAL CONDITION.

Nomini Creek is an important tributary of the Potomac River, which it enters about 82 miles below Washington, D. C. At the date of the survey preliminary to the inception of the improvement (1872) its navigation was obstructed by a bar of oyster shells and sand at its mouth over which but 3 feet could be carried at low tide. The dangers and difficulties of passing the bar were still further increased by strong cross tidal currents just inside the mouth at White Point. After passing the bar a wide and navigable stream is found in which 8 feet can be carried for about 4 miles to Nomini Ferry, while 5 feet can be carried for about 6 miles above the mouth.

PLAN OF IMPROVEMENT.

The original project adopted in 1873 provided for dredging a channel through the bar 100 feet wide and 9 feet deep at low tide, with side slopes of 2 to 1, at an estimated cost of $20,000. The project was amended in 1879 by increasing the width to 150 feet in order to meet the demands of increased trade. In 1885 the project was again modified so as to provide for a channel 200 feet wide and 9 feet deep, and also for dredging a training channel and the construction of training dikes. The total cost of this amended project was placed at $62,500. In 1888 this estimate was increased to $72,500, the channel having deteriorated during the suspension of work from 1883 to 1889. Owing to the position of the channel, exposed to north and northwest winds and to cross tidal currents, it is difficult to secure any permanent or satisfactory results. The deterioration of the channel outside White Point is believed to be largely due to material stirred up by northwest winds and carried into the channel by the ebb and flood currents of Currioman Bay. In order to maintain the channel and prevent this injurious action the project was modified in 1890 as follows: (1) The dredged channel to be 9 feet deep and 150 feet wide, this width being deemed sufficient for navigation and more likely to hold its depth. (2) Two jetties to be constructed, one from White Point on the east and one from Cedar Island on the west of the dredged channel, to extend out into Nomini Bay parallel to the channel. (3) Dikes to be built inside White Point to check the cross currents, but the training channel to be omitted. It is estimated that this modified project can be completed at a total cost of $72,500, which was the amount of the revised estimate of 1888 for a 200-foot channel.

WORK DONE AND RESULTS OBTAINED.

From March 3, 1873, to August 2, 1882, seven appropriations were made ranging from $2,000 to $10,000, and aggregating $32,500. These appropriations were applied to dredging a channel through the bar, which at the close of work in 1883 was 100 feet wide, 9 feet deep, and 4,400 feet long. Operations were then suspended until 1889, when an appropriation of $5,000, made August 11, 1888, was expended in widening and deeping the channel outside White Point, which had partly filled in during the cessation of work. The river and harbor act of

September 19, 1890, appropriated $5,000 for continuing the improvement. Under this appropriation dredging by contract in accordance with the modified project was commenced April 30, 1891, and completed June 19, 1891.

Ten thousand nine hundred and twenty-seven cubic yards of material were removed from the channel at and outside of White Point, the depth made being 9 feet at low tide and the width 150 feet outside of White Point and 130 feet directly at White Point. The dredged material was removed in scows and deposited in Nomini Bay near Kingcopsico Point. The dike across the channel to Bushfield Bay, inside White Point, was built of riprap stone, 406 cubic yards having been purchased for this purpose.

No work was done during the fiscal year ending June 30, 1892, the available funds having been applied to the work during the previous fiscal year.

FUTURE OPERATIONS.

The work remaining to be done for the completion of the project is the construction of the jetties and the continuation of the dredging to 150 feet width through the remainder of the bar. In order that the work may be done within the estimates, it is essential that the appropriations should be large enough to complete the jetties at one time. This will require $20,000. The total amount needed to complete the work is $20,000, and this can be profitably expended in one year.

APPROPRIATIONS.

The following appropriations have been made:

May 3, 1873	$10,000
June 23, 1874	6,000
March 3, 1875	5,000
March 5, 1879	2,500
June 14, 1880	5,000
March 3, 1881	2,000
August 2, 1882	2,000
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892	10,000
Total	52,500

The work is in the collection district of Tappahannock, which is the nearest port of entry. The nearest light-house is that at Blackistone Island.

Money statement.

July 1, 1891, balance unexpended	$2,552.11
June 30, 1892, amount expended during fiscal year	2,263.87
July 1, 1892, balance unexpended	288.24
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	10,288.24
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Tonnage for calendar year—	Tons.
1889	13,542
1890	15,825
1891 (furnished by Messrs. F. E. Tubman and A. L. Adler, Mount Holly, Va.)	62,300

No new lines of transportation were established in 1891. It is reported that the work done by the Government has maintained the trade of the section and made possible a large increase.

J 7.

IMPROVEMENT OF PATUXENT RIVER, MARYLAND.

ORIGINAL CONDITION.

The Patuxent River is navigable from its mouth at Drum Point, on Chesapeake Bay, for a distance of about 46 miles, as far as Bristol, Md. Vessels drawing from 10 to 12 feet can reach Holland Wharf, about 28 miles above the mouth, and a steamer drawing 8.5 feet when fully loaded runs up to Bristol.

Prior to the commencement of the improvement the navigation of the upper part of the river was obstructed by two mud bars, (1) Swann Point Bar, about 43 miles above the mouth, with a ruling depth of 7.8 feet, and (2) Bristol Bar, at Bristol, with a least depth off the steamboat wharf of 7.6 feet, and 4.2 off the county wharf. Two other bars below, viz, Pope Shoal, about 24 miles above the mouth, and Warren Reach Bar, about 34 miles above the mouth, were mentioned in the report of the preliminary examination as worthy of survey, but they appear to offer no obstruction to the present standard of navigation.

PLAN OF IMPROVEMENT.

The original project proposed a cut 200 feet wide and from 12 to 13 feet deep through these bars, so as to secure a permanent channel about 100 feet wide and 12 feet deep at low tide, at an estimated cost of $80,000. Under this project a channel 120 feet wide and 12 feet deep was dredged at Bristol Bar. Upon examination of the river in 1890 it appeared that a channel about 100 feet wide and 9 feet deep at Swann Point Bar would afford all the facilities that the existing or immediately prospective demands of commerce would require. The steamer navigating the upper part of the river draws, as stated, but 8.5 feet when fully loaded, but is, as a matter of fact, never fully loaded when passing this bar. So far as could be learned few sailing vessels go as high up as Bristol, and none drawing as much as 9 feet. The project was therefore modified so as to provide, in addition to the channel already dredged at Bristol Bar, a channel at Swann Point Bar about 100 feet wide and 9 feet deep, to be supplemented by works of contraction if these should afterward be found necessary.

WORK DONE AND RESULTS OBTAINED.

The first appropriation was made August 11, 1888, amounting to $5,000, which was applied to dredging by contract at Bristol Bar. A channel 12 feet deep, 120 feet wide, and 794 feet long, was dredged from the 12-foot curve at the lower end of the bar to a point about 250 feet above the steamboat wharf. The amount of dredging was 18,295 cubic

yards, and the channel was completed January 2, 1890. The material was mud.

In the river and harbor act of September 19, 1890, an appropriation of $6,000 was made for this improvement. Under this appropriation dredging by contract at Swann Point Bar was commenced April 9, 1891, and completed June 4, 1891. A channel 9 feet deep and 132 feet wide was dredged through the bar. This width of cutting will give a bottom width of fully 100 feet, when the sides of the channel have assumed their natural slope. The total amount of dredging was 19,525.7 cubic yards, which was removed in scows. The dredged channel is about 2,250 feet long.

FUTURE OPERATIONS.

The work already done on this river is sufficient for its present trade and navigation. It is possible that works of contraction may be required to maintain the channel at Swann Point Bar, the bar being composed of mud; but this question can only be determined by surveys to be made in the future. If the trade of the river should increase so as to demand deeper-draft steamers and vessels, a plan of improvement corresponding to these demands will be proposed, but at the present time no further appropriations are recommended.

APPROPRIATIONS.

The following appropriations have been made:

August 11, 1888	$5,000
September 19, 1890	6,000
Total	11,000

The work is in the collection district of Annapolis. The nearest light-house is that at Drum Point, Maryland.

Money statement.

July 1, 1891, balance unexpended	$1,184.84
June 30, 1892, amount expended during fiscal year	263.97
July 1, 1892, balance unexpended	920.87

COMMERCIAL STATISTICS.

Efforts were made to obtain commercial statistics, but the information received was not sufficiently definite for use. It was reported, however, that the business done in 1891 was larger than it has been for many years.

J 8.

IMPROVEMENT OF RAPPAHANNOCK RIVER, VIRGINIA.

DESCRIPTION.

The Rappahannock River is navigable from its mouth in Chesapeake Bay to Fredericksburg, Va., a distance of 106 miles. The lower

part of the river has the character of a tidal estuary, the width varying from 1 to 3.5 miles. The ruling depth at the mouth is 5 fathoms, and this depth holds to Jones Point, 28 miles above, while 17 feet can be carried to within 1 mile of Tappahannock, which is 41 miles from the mouth. Above Tappahannock the river has a tortuous course, and above Port Royal, 29 miles from Fredericksburg, it flows between high banks. The width at Fredericksburg is about 350 feet, gradually increasing to about 1,500 feet at Port Royal. In 1871, prior to the inception of the improvement, 6 feet could be carried within a mile of Fredericksburg, and then 4 feet to the town.

The Rappahannock River drains a large area of agricultural country and is subject to freshets. The highest known freshet occurred in June, 1889, when the river rose to 32.8 feet above low tide at Fredericksburg. The freshet slope falls below Fredericksburg as the river widens. Freshets are but little felt at Port Royal, and not at all at Tappahannock. They bring down large quantities of sediment, and are the chief factors in bar formation. Tides range from 2.5 feet at the mouth to 3.4 feet at Fredericksburg.

ORIGINAL CONDITION.

The obstructions to navigation lie between Tappahannock and Fredericksburg, 65 miles. The original condition of the bars was as follows:

Naylor Hole, 44 miles above the mouth. A detailed survey of the bar, made in 1885, showed the least depth to be 10.7 feet. The length of the bar between the 15-foot curves was 11,000 feet. Borings showed sand, mud, and gravel.

Nanzatico Reach, 72 miles above the mouth and 4 miles below Port Royal. The ruling depth on the bar is 10.1 feet (survey of 1885), although in the track which can be conveniently followed by steamers the depth is 8.3 feet. The length of the bar between the 15-foot curves is 5,540 feet. The bar is composed for the most part of soft mud.

Farleyvale Bar, 94 miles above the mouth, and 12 miles below Fredericksburg. In 1881, before improvement, 9 feet could be carried over this bar, although the depth on the best course was 8.3 feet. The bar was composed of sand, mud and gravel, and was about 200 feet long between the 10-foot curves.

Castle Ferry Bar, 93 miles above the mouth and 8 miles below Fredericksburg. The least depth in 1876, before improvement, was 8.4 feet, and the length between the 10-foot curves 1,400 feet. The bar is composed of sand and mud.

Spottswood Bar, 102 miles above the mouth, 4 miles below Fredericksburg. In 1871 this bar was 5,400 feet long, with a least depth of 6 feet at the "cross over," where there were three wrecks sunk during the late war. Before improvement this was the most troublesome bar on the river below Fredericksburg Bar, and steamers often grounded here.

Pratt Reach Bar, 103 miles above the mouth and 3 miles below Fredericksburg. The ruling depth before improvement was 8.1 feet, and the length between the 10-foot curves about 1,000 feet. The bar is formed of sand and mud.

Bernard Bar, 104 miles above the mouth, and 2 miles below Fredericksburg. The ruling depth before improvement was 9.1 feet and the length between the 10-foot curves about 400 feet. The material is sand and gravel.

Pollock Bar, 105 miles above the mouth of the river and one mile below Fredericksburg. The bar was about 700 feet long in 1882, be-

fore its improvement was commenced, and the ruling depth 7 feet. At the head of the bar and near the right bank there was a ledge of rock on which the depth was from 6 to 7 feet.

Fredericksburg Bar.—This bar commences 1 mile below the railroad bridge at Fredericksburg, and extends up to and along the entire wharf front of the town to the bridge. The ruling depth in 1871 was 4 feet. The bar was formed and is constantly renewed by deposits of sand brought down by the recurring freshets. In 1871 six wrecks obstructed the channel over this bar.

The navigation of the Rappahannock is sometimes obstructed by trees and snags carried into the river by freshets.

PLAN OF IMPROVEMENT.

The original project, approved in 1871, was to secure a channel 100 feet wide and 10 feet deep by dredging and the construction of dikes from Fredericksburg to Tappahannock, the wrecks obstructing the channel to be removed. The first estimate of the cost of this improvement was $83,760. In 1879 the project was amended so as to provide for dredging a channel 100 feet wide and 10 feet deep through the bars between Fredericksburg and Port Royal, and one 200 feet wide and 15 feet deep between Port Royal and Tappahannock for a larger class of vessels. The depths secured by dredging were to be maintained by a system of wing dams and training dikes. The total estimated cost of the revised project was $381,500.

WORK DONE AND RESULTS OBTAINED.

The first appropriation for the improvement was made March 3, 1871, amounting to $15,000. From March 3, 1871, to June 30, 1890, fourteen appropriations have been made, ranging from $5,000 to $25,000, and aggregating $199,500. These appropriations have been expended in improving the seven bars between Fredericksburg and Port Royal, by dredging, the construction of dikes, and the removal of wrecks and snags.

The following table gives the results of the improvement at each of the bars in January, 1890:

Locality.	Depth at low water before improvement.	Least channel depth at low water, January, 1890.
	Feet.	*Feet.*
Fredericksburg Bar, below steamboat wharf	*4	†8
Pollock Bar	7.8	9
Bernard Bar	8.5	9
Pratt Bar	8.3	9
Spottswood Bar, upper	6	8.5
Spottswood Bar, lower	6	8
Castle Ferry Bar	8	9.5
Farleyvale Bar	8	9.5

*About.

†A small bar exists at and immediately below the steamboat wharf, at which the least depth is about 6.5 feet; but it is comparatively unimportant, since it is just at the head of navigation.

Stated in general terms, about two-thirds of the work to be accomplished under the project between Fredericksburg and Farleyvale, a distance of 12.6 miles, has been done.

Nothing has been done toward the improvement of the bars at Nanzatico Reach, 33 miles below Fredericksburg, and near Tappahannock, 61 miles below Fredericksburg. It is considered more important to first complete the improvement above.

An appropriation of $15,000 was made in the river and harbor act of September 19, 1890. During the fiscal year ending June 30, 1891, the dikes at Fredericksburg Bar, Pollock Bar, Bernard Bar, Spottswood Bar, and Castle Ferry Bar were repaired and mattressed.

A contract was entered into April 24, 1891, with H. T. Morrison & Co., of Petersburg, for constructing a combined steam derrick boat and pile-driver, one scow, and two flatboats, for the sum of $6,129.75, this plant to be used on the Rappahannock, Mattaponi, and Pamunkey rivers. At the close of the last fiscal year, June 30, 1891, the plant was nearly ready. It was completed and delivered at West Point, Va., for use first on the Pamunkey and Mattaponi rivers on July 15, 1891. One-half of the cost was paid from the appropriation for Rappahannock River, one-fourth from the appropriation for the Mattaponi River, and one-fourth from the appropriation for the Pamunkey River.

A contract for dredging at Fredericksburg Bar was entered into on May 28, 1891, with Frank C. Somers, of Camden, N. J., at 31 cents per cubic yard.

Work under this contract was commenced September 14, 1891. Owing to the limited amount available for dredging but a small amount of work could be done and operations were therefore confined to those portions of the bar giving the greatest trouble to steamers. Channels 10 feet deep and from 40 to 80 feet wide were dredged at the lower end of the bar below Deep Run and near the upper end of the bar just below the steamboat wharf. The excavated material was removed in scows, dumped in front of the dikes, and then redredged and deposited behind the dikes, two clam-shell dredges being used for this purpose. Dredging operations were concluded October 17, 1891. The total amount of dredging under this contract was 18,028 cubic yards.

After the completion of snagging operations on the Pamunkey and Mattaponi rivers the plant was brought around through Chesapeake Bay to the Rappahannock River, arriving at Fredericksburg on December 11, 1891. After refitting the machinery a sunken scow was removed from the channel near Hazel Run. The scow was 38 feet long, 15.5 feet wide, and 3 feet deep. Its removal occupied two days and was completed December 15, 1891. The plant then proceeded down the river and was laid up for the winter at Leedstown, Va. One snag and four fallen trees were removed en route.

FUTURE OPERATIONS.

The work remaining to be done under the project is the improvement of the two bars between Port Royal and Fredericksburg, and the dredging and dike construction necessary to secure and maintain a channel 10 feet deep and 100 feet wide through the seven bars between Fredericksburg and Port Royal. As each freshet brings new deposits of sand and silt into the river, particularly at Fredericksburg Bar, the head of tide water, an annual appropriation of about $7,500 will be required for its maintenance.

APPROPRIATIONS.

The following appropriations have been made:

March 3, 1871	$15,000	March 3, 1881	$15,000
June 10, 1872	15,000	August 2, 1882	17,000
March 3, 1873	15,000	July 5, 1884	20,000
June 23, 1874	7,000	August 5, 1886	20,000
March 3, 1875	5,000	August 11, 1888 ($15,000, of which $3,000 was for Urbana)	12,000
August 14, 1876	10,000	September 19, 1890	15,000
June 18, 1878	13,500	July 13, 1892	20,000
March 3, 1879	10,000		
June 14, 1880	25,000		

The work is in the collection district of Tappahannock, which is the nearest port of entry. The nearest light-house is Bowler Rock light-house in the fifth light-house district.

Money statement.

July 1, 1891, balance unexpended	$14,162.83
June 30, 1892, amount expended during fiscal year	11,193.24
July 1, 1892, balance unexpended	2,969.59
July 1, 1892, outstanding liabilities	119.00
July 1, 1892, balance available	2,850.59
Amount appropriated by act approved July 13, 1892	20,000.00
Amount available for fiscal year ending June 30, 1893	22,850.59
Amount (estimated) required for completion of existing project	144,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Tonnage for—	Tons.
1888	83,600
1890	83,830

Efforts were made to procure commercial statistics for 1891, but no satisfactory statement could be obtained.

J 9.

IMPROVEMENT OF URBANA CREEK, VIRGINIA.

ORIGINAL CONDITION.

Urbana Creek is a tributary of the Rappahannock River, which it enters 16 miles above the mouth. Navigation was obstructed in 1874 by a bar outside the mouth, over which but 6.5 feet could be carried. In 1882, after the improvement had been commenced, a shoal within the creek having a least depth of 7 feet, and near the town of Urbana, was regarded as an obstruction to steamboat navigation.

PLAN OF IMPROVEMENT.

The approved project, adopted in 1879, was the excavation of a channel 150 feet wide and 10 feet deep through the outer bar, at an estimated cost of $20,000. The project was modified in 1883 so as to include dredging a channel through the shoal within the creek, and in 1888 so as to include a system of dikes or jetties along the sand spit at the mouth to prevent the natural channel from closing. The revised estimate for the entire project was $34,580.

WORK DONE AND RESULTS OBTAINED.

From March 3, 1879, to August 11, 1888, five appropriations ranging from $2,500 to $5,000 and aggregating $18,500, were made and expended in dredging channels through the bar outside the mouth, and the shoal within the creek, and in the construction of dikes and jetties on the sand spit. From 1883 to 1889 work was suspended for want of funds.

In 1882 the channel through the outer bar had been dredged to a width of 140 feet and a depth of 10 feet, but owing to the action of storms and the cessation of work the width had diminished to 90 feet. The natural channel has been widened at the end of the sand spit, and at the turn just outside the spit. A channel 10 feet deep and from 80 to 170 feet wide has been dredged at the shoal inside the creek. Two jetties and a dike have been built on the sand spit.

The river and harbor act approved September 19, 1890, appropriated $3,000 for continuing the improvement. On May 28, 1891, a contract was entered into, after public advertisement, with Frank C. Somers, of Camden, N. J., for widening the natural channel by dredging at the end of the sand spit, the price being 26.5 cents per cubic yard. Work under this contract was commenced October 26, 1891, and completed November 20, 1891. The depth made was 10 feet at low tide, and the channel width was increased by 70 feet. The total amount of dredging under the contract was 5,674 cubic yards. The dredged material was sand, and was removed in scows and dumped in deep water in the Rappahannock River about 1.5 miles below the mouth of the channel. No work was done on the jetties during the fiscal year ending June 30, 1892.

FUTURE OPERATIONS.

For the completion of the work under the existing project there remains the further dredging of the channel through the outer bar and the shoal within the creek, and the construction of jetties. Owing to the exposed position of the outer bar it will be difficult to maintain a channel through it. Past experience shows that without protecting works a dredged channel must eventually shoal from the action of the east to northeast storms, while protecting works in such an exposed locality must necessarily be expensive. While the improvement made has been of benefit to navigation by permitting the entrance of sailing vessels to the creek, the steamers do not use the channel, but land at a wharf on the Rappahannock about 1.5 miles from the town. The pilots of steamers are opposed to entering the creek, as they find the bend in the natural channel just outside the spit difficult, if not dangerous, in northeast and northwest winds. If this improvement is to be continued, larger appropriations should be made. The amount required to complete the existing project is $10,080.

The following appropriations have been made:

March 3, 1879	$5,000
June 14, 1880	2,500
March 3, 1881	4,000
August 2, 1882	4,000
August 11, 1888 (included in appropriation of $15,000 for Rappahannock River)	3,000
September 19, 1890	3,000
July 13, 1892	3,000
Total	24,500

Urbana is a port of entry in the collection district of Tappahannock. The nearest light-house is that at Bowler Rock.

Money statement.

July 1, 1891, balance unexpended	$3,000.00
June 30, 1892, amount expended during fiscal year	1,859.04
July 1, 1892, balance unexpended	1,140.96
July 1, 1892, outstanding liabilities	175.00
July 1, 1892, balance available	965.96
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,965.96
Amount (estimated) required for completion of existing project	10,080.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,080.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Tonnage for calendar year—	Tons.
1890	5,350
1891, reported by Mr. F. A. Bristow as	19,500
reported by Mr. J. D. Cressit as	22,100

Arrival and departure of vessels, 1891.

	No.	Tonnage.
Steamers drawing less than 10 feet	10	1,000
Sailing vessels drawing less than 10 feet	100	5,000

J 10.

IMPROVEMENT OF YORK RIVER, VIRGINIA.

ORIGINAL CONDITION.

The York River is formed by the union of the Mattaponi and Pamunkey rivers at West Point, Va., is 41 miles in length, and empties into Chesapeake Bay about 16 miles above Old Point. Entering the river 24 feet can be carried for 32 miles up to Potopotank Bar, 9 miles below West Point. In 1880 the ruling depth on this bar was 18.5 feet, and its length between the 20-foot curves was 2,200 feet. The next obstruction to navigation is West Point Bar, which commences about 2 miles below West Point and extends up to West Point. West Point is the shipping point of the Richmond and West Point Terminal Railroad system. The wharves from which shipments are made are built within the mouth of the Pamunkey River, and further obstruction to navigation was found in shoal water in front of these wharves.

PLAN OF IMPROVEMENT.

The original project, adopted in 1880, proposed the dredging of a channel 22 feet deep and 200 feet wide through the bars at Potopotank

and West Point, with an increased width at the wharves at West Point. In 1884, on account of the increased trade, the project was modified, by increasing the width of the proposed channel to 400 feet at a total estimated cost of $256,000. In 1887 the project was again amended to include the construction of a dike along the right bank of the river at West Point Bar, in order to prevent the deposit of silt in the dredged channel. The estimated cost of this dike was $52,800, making the total estimated cost of the improvement $308,800.

WORK DONE AND RESULTS OBTAINED.

From June 14, 1880, to August 11, 1888, six appropriations, ranging from $10,000 to $30,000, and aggregating $128,750, were made for this improvement.

Up to June 30, 1890, the following work had been done: A channel 105 feet wide and 22 feet deep was dredged in 1880–'81 through Potopotank Bar, 58,809 cublic yards of material having been dredged, at 15 cents per cubic yard. This channel in January, 1890, had a depth of from 20.8 to 21.7 feet.

At West Point Bar 795,704 cubic yards were dredged from 1881 to 1889 under successive appropriations at rates varying from 8.5 to 16 cents per cubic yard, which gave a channel through the bar with a width varying from 161 to 257 feet, and a depth, exclusive of the center cut, of not less than 22 feet. Under a modification of the project by the Secretary of War, January 4, 1889, a cut 40 feet wide and 24 feet deep was dredged near the center of the channel from the lower wharf at West Point to the second turn in the channel. In January, 1890, the ruling depth in this cut had been reduced by silting to 20.6 feet and in the rest of the channel to 19 feet. From the commencement of the improvement in 1881 to June 30, 1890, it has been necessary to redredge 152,595 cubic yards of silting which was not provided for in the original estimate, or about one-fifth of the total amount dredged at West Point Bar. The total amount expended to June 30, 1891, was $129,910.17.

In the river and harbor act approved September 19, 1890, an appropriation of $30,000 was made for continuing the improvement. After due public advertisement a contract was entered into on March 9, 1891, with the Baltimore Dredging Company, of Baltimore, Md., for dredging material from the channel and depositing it in embankment on the flats along the line of the proposed dike at 14⅞ cents per cubic yard. Owing to the extremely soft character of the mud composing the flats, the formation of the embankment was, after repeated efforts, found to be impracticable, and on May 11, 1891, a supplemental agreement was entered into with the Baltimore Dredging Company for dredging in the channel at 9 cents per cubic yard, and depositing the material on dumping grounds along the river to be secured by the contractor, but subject to the approval of the engineer. The circumstances attending the modification of this contract are fully set forth in the annual report of June 30, 1891.

Dredging under the modified contract was commenced June 10, 1891, and at the close of the last fiscal year, June 30, 1891, was still in progress. From June 10 to July 20, 1891, a channel 160 feet wide, 22 feet deep, and about 2,700 feet long, was dredged in front of the West Point wharves, this work being at the upper end of the 400-foot channel proposed under the approved project.

During the cessation of dredging operations the lower end of the

channel at the turn—between Buoys 13 and 15—had shoaled to about 18 feet in depth at low tide. This part of the channel was, therefore, redredged for a distance of about 3,300 feet to 22 feet in depth, and to a width of 160 feet. Work under this contract was closed September 3, 1891. The total amount of dredging was 166,130 cubic yards. Of this amount 95,173 cubic yards was redredging. The material found near the wharves was mud and sand, the latter forming the lower stratum. The material in the lower channel was very soft mud. The dredgings were deposited on a dumping ground on the Mattaponi River above West Point, and also within the 9-foot curve on the left of the York River Channel near Hackley Creek. Great difficulty was experienced in finding dumping grounds. All available grounds for scow dumping near West Point are now filled. The flats on either side of the channel are extensively occupied by oyster beds, the owners of which object strenuously to any further dumping.

FUTURE OPERATIONS.

Future operations proposed are the completion of the channels at West Point and Potopotank bars, and the construction of the dike at West Point Bar, in order to maintain the channel secured by dredging. Occupants of oyster beds on these flats object to the construction of the dike, and claim that it will injure their oyster beds.

On the basis of the original estimate the amount required for the completion of the project is $115,050, but owing to the continued shoaling of the channel, this amount will probably be insufficient.

The trade of the York River is large, increasing, and important, and the improvement is worthy of liberal appropriations by Congress.

APPROPRIATIONS.

The following appropriations have been made:

June 14, 1880	$10,000
March 3, 1881	25,000
August 2, 1882	25,000
July 5, 1884	20,000
August 5, 1886	18,750
August 11, 1888	30,000
September 19, 1890	30,000
July 13, 1892	35,000

This work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Bell Rock, in the Fifth light-house district.

Money statement.

July 1, 1891, balance unexpended	$28,879.83
June 30, 1892, amount expended during fiscal year	16,054.01
July 1, 1892, balance unexpended	12,825.82
Amount appropriated by act approved July 13, 1892	35,000.00
Amount available for fiscal year ending June 30, 1893	47,825.82
Amount (estimated) required for completion of existing project	115,050.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Furnished by Mr. E. T. Lamb, West Point, Va., for calendar year 1891.]

	Tons.
Coal	10,960
Cotton	89,227
Farm produce	5,641
Grain	3,220
Iron	43,897
Lumber	7,848
Oysters	12,400
General merchandise	70,355
Railroad ties	14,140
Tobacco	175
Wood	45,900
Rosin	100
Oil	475

Vessels arriving and departing.

	Number.
Steamers drawing 10 feet or more	727
Steamers drawing less than 10 feet	104
Vessels drawing 10 feet or more	178
Vessels drawing less than 10 feet	824
Barges, flatboats, etc	191

Statement of tonnage by years.

Reported for—	Tons.
1888	285,480
1889	328,353
1890	418,190
1891	304,338

No new lines of transportation were established in 1891.

J II.

IMPROVEMENT OF MATTAPONI RIVER, VIRGINIA.

The Mattaponi River is navigable for small steamers and vessels from its mouth at West Point to Ayletts, a distance of about 52 miles, and can be made navigable for barges for 26 miles above Ayletts, to Munday Bridge. The obstructions to 5.5-foot navigation below Ayletts are as follows:

Designation.	Approximate distance below Ayletts.	Length of bar.	Ruling depth.
	Miles.	*Feet.*	*Feet.*
Latane Bar	11	2,900	3.6
Robinson Bar	8	3,500	3.4
Presque Isle Bar	7	1,200	2.0
Sale Bar	6½	800	2.0
Walker Bar	4	1,000	2.5
Old Hall Bar	1	900	2.5

Of the above-named bars only the first two have been surveyed, and the lengths and depths at the others are approximate only. Above

Ayletts there were eight bars, but no work on them was proposed. The river was also obstructed by snags, overhanging trees, and wrecks.

PLAN OF IMPROVEMENT.

The proposed plan of improvement was to remove snags, logs, leaning trees, wrecks, etc., below Munday Bridge, and to improve the bars below Ayletts so as to give a depth of 5.5 feet at low tide, and a channel width of 40 feet.

WORK DONE AND RESULTS OBTAINED.

From June 14, 1880, to August 11, 1888, five appropriations, ranging from $2,500 to $5,000 and aggregating $16,300, had been made for this work and the entire amount expended. On June 30, 1890, the following results had been obtained: Snags, wrecks, and overhanging trees had been removed from Robinson Bar to Munday Bridge, a distance of about 34 miles, and 2,226 linear feet of dike had been built at Robinson Bar. No dredging has yet been done on the river. In the river and harbor act approved September 19, 1890, an appropriation of $3,000 was made, $1,500 of which could be expended above Ayletts. As this amount was insufficient for dredging operations it was applied to the removal of snags, logs, and similar obstructions which accumulate each year and obstruct navigation. The plant formerly used for this purpose on the Rappahannock, Mattaponi, and Pamunkey rivers had become worn out, and it became necessary to build a new plant before snagging could be commenced. Plans were prepared and proposals invited for the construction of a plant consisting of one combined steam hoister and pile-driver, one scow, and two flatboats. A contract for the same was entered into with H. T. Morrison & Co., of Petersburg, Va., for the sum of $6,129.75, and at the close of the fiscal year the plant was nearly completed.

On July 15, 1891, it was delivered at West Point, Va., and first used on the Pamunkey River. One-fourth of the cost of the plant was charged to the Mattaponi River, one-fourth to the Pamunkey River, and one-half to the Rappahannock River.

The removal of snags, etc., on the Mattaponi River was commenced October 1, 1891. After refitting and the purchase of supplies at West Point, Va., the plant proceeded up the river as far as Ayletts, removing snags, logs, and overhanging trees en route. An examination was then made of the river above Ayletts as far as Dunkirk. Numerous snags, etc., were found obstructing the navigation, which is, however, limited to 7 scows towed by a small tugboat and conveying chiefly railroad ties and sawed lumber. The plant continued up the river to Dunkirk, removing obstructions, and reached that place on November 7, 1891. The return trip was then made, and snags, trees, etc., passed over in going up the river were removed. West Point was reached on November 21, 1891.

The work done during the season is as follows:

	Number.
Snags removed	165
Logs removed	27
Overhanging trees removed	210

At West Point the plant was fitted up for the transfer to the Rappahannock River, which was accomplished December 11, 1891.

FUTURE OPERATIONS.

The remaining work under the existing project is as follows: The completion of the dikes at Robinson Bar and the construction of those proposed at Latane Bar, and the dredging of channels at all of the bars below Ayletts having a ruling depth of less than 5.5 feet. Snags and fallen trees accumulate each year and will require removal. The estimated amount required for the completion of the existing project is $48,800, but as instrumental surveys have been made of but two bars this estimate will be subject to future revision.

APPROPRIATIONS.

The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	3,300
July 5, 1884	2,500
August 5, 1886	5,000
August 11, 1888	3,000
September 19, 1890	3,000
July 13, 1892	4,000

The work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Bell Rock, Va.

Money statement.

July 1, 1891, balance unexpended	$3,003.11
June 30, 1892, amount expended during fiscal year	2,870.50
July 1, 1892, balance unexpended	132.61
Amount appropriated by act approved July 13, 1892	4,000.00
Amount available for fiscal year ending June 30, 1893	4,132.61
Amount (estimated) required for completion of existing project	48,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Receipts and shipments for calendar years 1890 and 1891.

Class of goods.	1890.	1891.*
	Tons.	*Tons.*
Farm products		2,400
Grain		1,000
Lumber	7,700	1,200
Merchandise	10,400	3,120
Ties	6,900	5,640
Wood	7,650	38,700
Total	32,650	52,060

* Furnished by Mr. E. T. Lamb, West Point, Va.

It is reported that a steamer line between Walkerton and Dunkirk was established during the year.

J 12.

IMPROVEMENT OF PAMUNKEY RIVER, VIRGINIA.

The Pamunkey River is navigable from its mouth at West Point, on the York River, to Hanovertown or Dabney Ferry, a distance of about 59 miles. Seven feet can be carried to Piping Tree Ferry, a distance of 43 miles. The following are the principal bars obstructing navigation:

Designation.	Distance above West Point.	Length of bar.	Least depth.
	Miles.	*Feet.*	*Feet.*
Spring Bar	43.5	700	5.6
Skidmore Bar	47.5	600	5.8
Whale Back Bar	53.5	700	3.
Potomoy Creek	56.	400	1.5
Indian Table	58.	....	(*)

* Exposed at low tide.

In addition to these bars, navigation was originally obstructed by numerous wrecks, logs, snags, and overhanging trees.

PLAN OF IMPROVEMENT.

The project for the improvement, adopted in 1880 and amended in 1885, provides for 7-foot navigation from West Point to Bassett Ferry, 47 miles; thence 5-foot navigation to Wormley Landing, 54 miles above West Point, and thence 3-foot navigation to Hanovertown, the 7-foot channel to be 100 feet wide and the remainder 40 feet wide. The wrecks, snags, logs, and trees obstructing navigation between Garlick Ferry and Hanovertown were also to be removed.

WORK DONE AND RESULTS OBTAINED.

From June 14, 1880, to August 11, 1888, five appropriations were made, ranging from $2,500 to $5,000, and aggregating $15,500. The following work has been done: Snags, logs, and overhanging trees have been removed from the river between Hanovertown and Garlick Ferry, a distance of 22.5 miles. Parts of wrecks obstructing navigation have been removed, as follows: Three at Skidmore Bar, three at Carter Island, and one at White House. Nine hundred and eleven feet of dike have been constructed at Skidmore and Spring Bars, and a channel 800 feet long, 95 feet wide, and from 6 to 7 feet deep has been dredged through Skidmore Bar.

The river and harbor act approved September 19, 1890, appropriated $3,000 for continuing the improvement. This amount was too small to be advantageously applied to dredging operations. The removal of snags, logs, and overhanging trees, which are brought into the river each year by freshets, was, however, needed, and it was decided to apply the funds to this work. The plant formerly used on the Rappahannock, Mattaponi, and Pamunkey rivers, was worn out, and it was neccessary to build a new one before active operations could be commenced. Plans were prepared and a contract entered into with H. T. Morrison & Co., of Petersburg, Va., for a plant, to consist of a com-

bined steam hoister and pile driver, one scow, and two flat boats, at a cost of $6,129.75. One-fourth of the cost of the plant was charged to the appropriation for the Pamunkey River. The plant was delivered at West Point, Va., July 15, 1891. After the purchase of coal and supplies at West Point the plant proceeded up the river, removing the most serious obstructions en route. No snags and but few logs or trees were found below Skidmore Bar, but above this locality, near Clifton Landing, the river was found nearly closed to navigation by obstructions of this character. Work was delayed six days in August (25–30) by a freshet, which rose 8 feet above high-water mark. In September (7–10) another freshet occurred, rising 12 feet above high-water mark.

Hanovertown, or Dabney Ferry, was reached about September 1, 1891, and the plant then turned and proceeded downstream, removing the less important obstructions and those not seen on the upward trip. West Point was reached on September 26, 1891, and preparations then made for similar work on the Mattaponi River. The obstructions removed on the Pamunkey River were as follows:

	No.
Snags removed	103
Logs removed	37
Overhanging and fallen trees removed	103

FUTURE OPERATIONS.

The work remaining to complete the project is the dredging of channels at Spring Bar and at the three unimproved bars above, with such further work in removing obstructions as may be found necessary. The estimated cost of completing the project is $7,000.

APPROPRIATIONS.

The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	2,500
August 2, 1882	2,500
August 5, 1886	5,000
August 11, 1888	3,000
September 19, 1890	3,000
July 13, 1892	3,000

The work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Bell Rock, Virginia.

Money statement.

July 1, 1891, balance unexpended	$3,016.36
June 30, 1892, amount expended during fiscal year	2,963.02
July 1, 1892, balance unexpended	53.34
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,053.34
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Furnished by Mr. E. T. Lamb, West Point, Va.]

	Tons.
Tonnage for year 1891	234,337

Arrivals and departures of vessels.

	No.	Tonnage.
Steam, drawing 10 feet or more	727	1,126,312
Steam, drawing less than 10 feet	104	12,480
Sail, drawing 10 feet or more	49	3,427
Sail, drawing less than 10 feet	52	1,306
Barges, flatboats, etc	20	2,000

J 13.

[Printed in House Ex. Doc. No. 30, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF EASTERN BRANCH OF THE POTOMAC RIVER (ANACOSTIA RIVER), INCLUDING THAT PORTION IN DISTRICT OF COLUMBIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., September 25, 1890.

GENERAL: In compliance with department order of September 20, 1890, relative to the making of preliminary examinations of certain harbors and rivers in my district, I have to report that I have made such an examination of the "Eastern Branch of the Potomac River, Maryland, including that portion in the District of Columbia," and report as follows:

So far as the portion of the river lying beyond the limits of the District of Columbia and within the State of Maryland is concerned, I see no reason for changing the opinion already expressed in my report of November 7, 1888, that that portion of the river is not worthy of improvement.

The lower portion of the river is of much greater importance. There is considerable commerce on this, and the lack of wharf room on the main stem of the river, as well as the natural growth of the capital, will cause an expansion of the commerce of the Eastern Branch. More important than this, however, at the present time, is the fact that one of the most important navy-yards of the Government is located on this stream, and the channel of the river is so narrow, crooked, and shallow that but few Government vessels can reach the yard. The river is certainly worthy of improvement. A survey will be needed to determine the nature and extent of the improvement and an estimate of the cost. I estimate that the survey can be made for about $400.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF EASTERN BRANCH OF THE POTOMAC RIVER (ANACOSTIA RIVER), INCLUDING THAT PORTION IN DISTRICT OF COLUMBIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., October 24, 1891.

GENERAL: I have the honor to submit the following report of a survey of the Eastern Branch of the Potomac River (Anacostia River), including that portion in the District of Columbia, made in compliance with the requirements of the act of September 19, 1890.

The harbor and river act of August 11, 1888, contains an item directing an examination or survey of the Eastern Branch of the Potomac River (Anacostia), in the State of Maryland, and a report of such examination was made by me November 7, 1888, in which I stated that in my opinion the Eastern Branch of the Potomac River lying in the State of Maryland is not worthy of improvement by the National Government. So far as that portion of the river is concerned, I see no reason for changing the opinion expressed in that report.

In respect to that portion of the river within the District of Columbia the case is different. There is already a navigable depth of 18 feet up as far as the navy-yard, and Congress at its last session, in addition to the survey above referred to, authorized the expenditure of $20,000 of the money appropriated for the improvement of the Potomac River to be expended in improving the channel up to the navy-yard. Congress also made an appropriation of $10,000 for improving the channel, to be expended under the Navy Department. The necessity of improving the lower portion of the river has thus been officially recognized to the extent of appropriations aggregating $30,000 by the last Congress.

The Anacostia is a tidal estuary of the Potomac. The river from its mouth to the navy-yard is a wide stream, and the channel, though 18 feet deep, is narrow and crooked—so crooked in fact that a vessel 150 to 200 feet long, drawing 15 feet of water, can scarcely navigate it. On the south side of the deep channel there is a large area of shoal water or flats. Above the navy-yard the river is narrower, the average width being about 1,200 feet up as far as the crossing of the Pennsylvania Railroad. The channel depth in this part of the stream is about 13 feet. From the railroad bridge to Bennings Bridge there is a channel depth of not less than 6 feet, while much of it is from 9 to 10 feet deep at low tide. From Bennings Bridge to Bladensburg the stream is very narrow, with a depth of less than 6 feet and most of it with less than 3 feet. Along the borders of the channel, as far up as Bennings Bridge and for some distance above, there are large areas of flats or shoals which support a prolific growth of water grass and reeds.

The Government has established at the navy-yard a magnificent workshop for the fabrication of modern guns and other appliances of war for its navy. It has expended and will continue to expend large sums annually for increasing the facilities of this establishment. This navy-yard now seems destined to become the great workshop of the Navy Department. Its secure position in time of war must of necessity give it a prominent place as a naval establishment. For these reasons alone the Government has an immense interest in making the yard approachable by some of its large vessels. The channel depth, as stated, is already 18 feet, but it is narrow and crooked, and it is no unusual thing to see a Government vessel aground in the channel, although she may be of comparatively light draft. The keeping of the channel open for the Navy alone has been regarded as of so much importance that a steam dredg-

ing plant has for years been kept constantly on hand and frequently at work by the Navy Department, improving the channel as well as the docks in front of the yard. Frequent appropriations have been made by Congress and expended under the Navy Department for dredging the Anacostia River, no less than $50,000 having been expended on this account in the last twenty years. To say that the Eastern Branch of the Potomac should be improved, is only to say what Congress has virtually said when it made appropriations for the improvement. Besides the wants of the Navy Department, there are commercial reasons for improving the river between its mouth and the navy-yard bridge. The water front of this city is already overcrowded. The most of the shipping arriving and departing make their landings at wharves along the Washington Channel. The wharfage room here is not sufficient for the existing demands of commerce. The question of selling the reservation of Washington Barracks has already been considered in Congress, and more room is urgently demanded. If the capital is to grow, and grow it must, additional wharfage will be required. The most available space for it is on the bank of the Anacostia between Buzzards Point and the navy-yard, and to utilize it the channel must be widened and deepened.

There are reasons, however, other than purely commercial ones, which call for the improvement of this river. Nearly one-half of the sewage of the city of Washington is discharged into this stream. As the city grows the amount will increase. The effect of this will be to cause such pollution of the water that a most unsanitary state of affairs will be brought about sooner or later. The sewage will spread out on the flats and as these fill up higher and higher the odors from them will increase until a large part of the city bordering on it will be rendered unhealthy if not uninhabitable.

The question seems therefore to be, not, is the improvement desirable, but, how can it best be done? In answering this question it is important, in my opinion, that temporary expedients for ameliorating existing difficulties should not be adopted, but that due consideration should be given to the requirements of the future as well as the present and a plan formulated that looks to the future demands of a great city. Appropriations are made in small biennial installments, and this fact should not be lost sight of, so that the work of each year, be it little or great, should be in conformity to some comprehensive plan. Heretofore the channel has been dredged from time to time and the spoils deposited where it could be done at least expense.

It is scarcely within the range of probabilities that that portion of the river above the bridge of the Pennsylvania Railroad Company will need improvement for many years to come. From Bennings Bridge to the navy-yard the river does not need improvement at the present time, but doubtless will at no distant day. The part of the river to be improved would therefore, for the present at least, be that portion from the navy-yard bridge down to its mouth.

It is said that less than one hundred years ago vessels of considerable size loaded at Bladensburg, but I can find no maps of the river that show a navigable stream to that point. The river has filled up considerably from the deposits of freshets, which deposits have taken place from both directions. The lower part of the river has doubtless suffered more from the deposit of silt brought down the Potomac than from that brought down the river itself, and the reverse is doubtless true with respect to the upper part. The silting process is still going on, and must, from the nature of things, continue. This silting takes place only in times of freshets. At other times the river is comparatively clear, but the deposit from the sewers is continuous.

The tidal compartment of the Anacostia above Poplar Point, as calculated from maps of the Coast and Geodetic Survey and our own, is found to be as follows:

The area between a line normal to the axis of the stream at Poplar Point and Bennings Bridge is 37,854,200 square feet. The range of tides within this area is taken at 3 feet.

The tidal area between Bennings Bridge and Bladensburg is 9,303,650 square feet. The range of tides at Bladensburg is 2.1 feet, and the average range within the last-named area may be taken as 2.6 feet. The tidal prism between Poplar Point and Bladensburg will then be as follows:

	Cubic feet.
Poplar Point to Bladensburg, 37,584,200 × 3	112,752,600
Bennings Bridge to Bladensburg, 9,303,650 × 2.6	24,189,490
Total cubic feet	136,942,090

The fluvial discharge of the Anacostia River is about 60 cubic feet per second, so that on the ebb tide the above should be increased by 1,458,000 cubic feet, and on the flood decreased by 1,224,000 cubic feet.

Between the crossing of the Baltimore and Potomac Railroad and Bennings Bridge the tidal area is made up chiefly of flats and marshes, which are now overflowed at high tide, but which are gradually silting up, and which eventually will be raised in this way, or else reclaimed, so as to be above ordinary high tides. Above Bennings Bridge there is a small area of flats shoaling in the same way. These flats are already assuming a market value for agricultural purposes, and at no distant day will be diked in if not otherwise reclaimed. They can not be depended on as a part of the tidal compartment of the river in the future. If omitted, the tidal prism above Poplar Point will be reduced to 90,378,990 cubic feet.

As determined by the Coast and Geodetic Survey the duration of flood tide is five hours forty minutes and of ebb six hours forty-five minutes, while the same authority gives 2.9 feet as the mean rise and fall.

Supposing that the tidal compartment should remain unchanged, then, on a basis of a constant flow, the amount of water passing into it on flood tide, or out of it on the ebb, would not be enough to accomplish a reasonable amount of scouring effect on a wide channel, and when the tidal compartment becomes smaller the effect would be still further reduced.

It may be assumed that a channel of less width than about 1,000 feet will not meet the requirements of the future. Two hundred feet of such channel should have a depth of about 24 feet, as the Potomac itself will in all probability, at no distant day, be improved to that depth. The remaining 800 feet should be as follows: For 100 feet on each side of the 24-foot channel the bottom should slope upward to 12 feet, and from thence to either bank to 6 feet. The low-water section would then be 13,800 feet. This would be the ideal channel of the future and the ultimate project aimed at. The velocity of the current, either on flood or ebb, is not constant, but the amount of water passing into or out of the tidal compartment is too small to justify any hopes of scour that would materially benefit such a channel. With a tidal compartment as large as it is at present, the discharge per second at Poplar Point, based on a constant flow, would only be 5,695 cubic feet per second on ebb and 6,653 cubic feet per second on flood, and with the prism reduced to 90,378,990 it would be much less.

As before stated, however, the reclamation of the flats must soon become a necessity, and how can this be done in any way that will be more satisfactory than by making the improvement of the channel and the

filling of the flats a single job? Dredging is necessary. What will be done with the dredgings if they be not deposited on the flats? There are no suitable dumping grounds in the Potomac within reasonable distance. Dredgings are usually transported in scows. These scows when loaded draw from 8 to 12 feet of water. The consequence is they must be dumped in comparatively deep water, from whence they will in all probability ultimately be washed into the channel, or, if not, they will obstruct the part of the river used by light craft.

The disposal of the spoils of dredges is getting to be a serious matter on all tidal streams, and the most satisfactory way of accomplishing this object, when it is practicable, is to utilize them in filling neighboring flats or marshes. Land thus reclaimed from overflow assumes a market value in some cases sufficient to pay for the improvement of the navigation. It is so in the main branch of the Potomac River at Washington, and the case is almost identical in the Anacostia. The improvement of the channel will thus help to pay for itself, and the reclamation of the flats will produce a better sanitary condition of the neighborhood.

I would therefore recommend the following plan of improvement for the Anacostia River:

Dredge a channel from its mouth to the navy-yard bridge, 24 feet deep and 200 feet wide, with a basin in front of the yard 400 feet wide, of the same depth. This channel to be widened, at a reduced depth, to 1,000 feet as the demands of commerce require in the future. The material dredged to be deposited on the flats or marshes, on either side of the river, as may be most advantageous and economical at the time the appropriations are available. For the present it will be sufficient to dredge a channel 20 feet deep up as far as the navy-yard, as that is the ruling depth on the shoals in the Potomac at the present time.

The areas to be reclaimed as well as the channel to be dredged are indicated on the accompanying tracing.* That portion of the river above the navy-yard bridge, which in due time will need improvement, should be left for future consideration, but harbor lines should be established at an early day along the banks of the river from its mouth to Bennings Bridge.

The total amount of material to be dredged is 4,100,000 cubic yards, and, at an average cost of 16 cents per cubic yard, would make the total cost of the improvement below the navy-yard bridge $656,000. The total dredging to be done will not be sufficient to raise the entire area to the full height of 6 feet above low water, and for that reason the filling should first be made in the vicinity of Poplar Point. The lower part of the proposed fill can be made from dredgings in the Potomac, which will be necessary if the latter be improved to 24 feet.

The value of the land to be reclaimed, if the property of the United States, would be considerable. The 8 acres south of the Arsenal, which would undoubtedly belong to the United States, would be worth not less than $5,000 per acre. That on the opposite side of the river would be less.

Before the project is regularly entered upon steps should be taken to secure the title of the United States to all the land to be reclaimed. This will require the action of Congress.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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*Not reprinted; printed in House Ex. Doc. No. 30, Fifty-second Congress, first session.

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[Printed in House Ex. Doc. No. 33, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF POTOMAC RIVER, VIRGINIA AND MARYLAND, UP TO THE CITY OF WASHINGTON, WITH THE VIEW OF REMOVING OBSTRUCTIONS AND DEEPENING THE CHANNEL.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., September 26, 1890.

GENERAL: In compliance with Department order of September 20, 1890, relative to preliminary examinations of certain harbors and rivers in my district, I have to report that I have made a preliminary examination of the "Potomac River up to the city of Washington, with a view of removing obstructions and deepening the channel, Virginia and Maryland," and submit the following report:

The river is wide and deep from its mouth to the Kettle Bottoms, a distance of about 35 miles. The first obstructions are encountered here, and while navigation is impeded by the existence of shoal spots, there is, nevertheless, an available depth of about 21 feet in the channel. Above the Kettle Bottoms, to Maryland Point, the river has a wide and deep channel for the greater distance. Near Deep Point the channel is narrow and obstructed by shoal spots. At best only about 18 feet can be carried past it with safety. From thence to Washington City the channel is deep.

The commerce on the Potomac is large in amount, and annually increasing. Besides that, the National Government has a navy-yard on the Eastern Branch, where the largest ordnance for the armament of the navy is fabricated.

The river, in my opinion, is worthy of improvement, and a survey of the places where navigation is difficult should be made to determine what work is necessary and estimate its cost. I estimate the cost of such a survey to be $600.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SURVEY OF POTOMAC RIVER, VIRGINIA AND MARYLAND, UP TO THE CITY OF WASHINGTON, WITH THE VIEW OF REMOVING OBSTRUCTIONS AND DEEPENING THE CHANNEL.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., November 6, 1891.

GENERAL: In compliance with the instructions contained in your letter of September 20, 1890, I have the honor to submit the following report upon a survey of the "Potomac River up to the City of Washington, with the view of removing obstructions and deepening the channel," provided for by the river and harbor act approved September 19, 1890.

The Potomac River is 113 miles in length from its mouth to Georgetown, D. C., the present head of navigation for sailing vessels. The width of the river varies from 1,000 feet at Georgetown to 7 miles at the mouth.

The standard of navigation on which the survey was based was 24 feet at low tide, this depth being regarded as sufficient for the prospective needs of commerce. Any greater depth can only be had at enormous cost. The obstructions to 24-foot navigation occur at the following localities:

1. At the Kettle Bottom Shoals.
2. Near Maryland Point.
3. Near Smiths Point.
4. At Mattawoman Shoal, near Deep Point.
5. At the city of Washington.

(1) *Kettle Bottom Shoals.*—The Potomac, from its mouth to the Kettle Bottoms is a wide, deep stream, and vessels of 30 feet draft can pass up Chesapeake Bay and the Potomac as far as the Kettle Bottoms, 37 miles from the mouth. The Kettle Bottom Shoals, which are the first obstruction to navigation, extend from Cob Point at the mouth of the Wicomico River, Maryland, to Lower Cedar Point, a distance of 12 miles. The shoals consist of a number of lumps, old oyster beds underlaid with mud. These lumps, over which there is a depth of from 10 to 16 feet, are scattered about between Cob Point and Swan Point, in an irregular fashion, making navigation difficult for vessels drawing over 16 feet. Between the lumps the water is generally deep, but the channel is difficult to navigate. There is an old channel near the north bank of the river, said to have been formerly used, which can be made navigable for vessels drawing 24 feet at small cost. A survey of this channel was made, which shows that it now has an available depth of 23 feet for a width of 400 feet, and by dredging about 4,000 cubic yards a channel 200 feet wide and 24 feet deep can be secured. The range of tides at the Kettle Bottoms is 1.8 feet.

The estimated cost of the work needed at the Kettle Bottom Shoals to secure a width of 200 feet and a depth of 24 feet is as follows:

4,000 cubic yards dredging at 30 cents	$1,200
Contingencies, 10 per cent	120
	1,320

(2) *Maryland Point Shoal.*—After passing the Kettle Bottoms no further obstruction is found until Maryland Point Shoal is reached, 67 miles from the mouth of the river. The surveys made here showed the existence of a shoal about 7,000 feet in length between the 24-foot curves. The ruling depth on the shoal was found to be 22 feet at low tide. The shoal is composed of soft mud. The amount of dredging re-

quired to secure a channel 200 feet wide and 24 feet deep through this shoal, is 183,000 cubic yards. The width of the river at Maryland Point is 1½ miles, while at the bar (1½ miles above) the width is 3 miles. The range of tides is about 1.4 feet.

The estimated cost of a channel 200 feet wide and 24 feet deep through this shoal is as follows:

183,000 cubic yards dredging, at 15 cents	$27,450
Contingencies, 10 per cent	2,745
	30,195

(3) *Smiths Point Shoals.*—For a distance of about half a mile above the upper end of Maryland Point Shoal, the depth of water ranges from 24 to 27 feet. Another shoal is then found, which is situated about one mile below Smiths Point. The ruling depth over this shoal is 23.2 feet at low tide. The length of the bar between the 24-foot curves is 4,500 feet. The bottom is soft mud. The width of the river at this shoal is about 3 miles, the channel being near the easterly bank. The amount of dredging required to secure a channel 200 feet wide and 24 feet deep through this shoal is estimated at 78,000 cubic yards.

One-half of a mile above Smiths Point another shoal commences which is about 4,500 feet long, and has a ruling depth of 21 feet. In order to secure a channel 200 feet wide and 24 feet deep through this upper shoal it is estimated that 122,000 cubic yards of dredging will be required. The range of tides at Smiths Point is 1.4 feet. The estimated cost of the dredging required at the shoals near Smiths Point is as follows:

	Amount of dredging—cubic yards.
Smiths Point, lower shoal	78,000
Smiths Point, upper shoal	122,000
Total	200.000

200,000 cubic yards dredging at 15 cents	$30,000
Contingencies, 10 per cent	3,000
	33,000

(4) *Mattawoman Shoal.*—After passing Upper Smiths Point Shoal, no obstruction to 24-foot navigation is found until the mouth of Mattawoman Creek is reached, 82 miles above the mouth of the river, at which point Mattawoman Shoal commences. A survey of this shoal was made, which afforded the data necessary to determine the cost of the dredging required. The survey shows the length of the bar between the 24-foot curves to be 15,300 feet, and the ruling depth 19.5 feet at low tide. The bottom is, however, somewhat lumpy. The borings show that the lower part of the bar is composed of sand and gravel underlaid with mud, while the upper part is mud. The range of tides is 1.6 feet.

In order to make a channel 200 feet wide and 24 feet deep through this bar it will be necessary to dredge 569,000 cubic yards of material. The cost of this work is estimated as follows:

569,000 cubic yards dredging, at 15 cents	$85,350
Contingencies, 10 per cent	8,535
	93,885

(5) *At the city of Washington.*—From the upper end of Mattawoman Shoal to the city of Washington there is ample water for vessels drawing 24 feet. The project for the improvement of the Potomac River at

Washington, D. C., provides for channels 20 feet deep at low tide, and this depth was secured by dredging both in the Washington and Virginia channels. The estimate for 24-foot navigation, given below, provides, therefore, only for deepening the channels at Washington from 20 to 24 feet at low tide. The cost of this work is estimated as follows:

For a channel 200 feet wide and 24 feet deep in the Virginia channel and in the Washington Channel up to the wharves, and 300 feet wide and 24 feet deep in front of the wharves:

Virginia Channel, dredging 271,000 cubic yards, at 16 cents	$43, 360
Washington Channel, dredging 533,000 cubic yards, at 16 cents	85, 280
Contingencies, 10 per cent	12, 864
	141, 504

The entire cost of the improvement of the Potomac River for 24-foot navigation, from the mouth up to the city of Washington, would be as follows:

(1) Kettle Bottom Shoals	$1, 320
(2) Maryland Point Shoal	30, 195
(3) Smiths Point Shoals	33, 000
(4) Mattawoman Shoals	93, 885
(5) At the city of Washington	141, 504
	299, 904

The cost of a channel 400 feet wide and 24 feet deep would be about double the above.

It is believed that if the river were improved to a depth of 24 feet an impetus would be given to the trade of Georgetown. The reconstruction of the Chesapeake and Ohio Canal has recently been completed, and if facilities were afforded for deeper-draft vessels large quantities of coal and produce from the interior would undoubtedly be shipped from this port.

Besides the commercial interests involved the Government itself has strong reasons for improving the Potomac River, in order that its vessels of war may reach the navy-yard at Washington, where the new naval gun factory is situated. It is understood that at the present time the guns for our cruisers, manufactured at this yard, have to be shipped to other ports, as most of the vessels can not come here for want of sufficient depth of water. It would therefore be a great advantage to the Government if the obstructions referred to were removed.

It is probable that works of contraction may be needed at some of the points named, in order to maintain a deep channel after it has been made, but the conditions are different at each locality, and each would have to receive further study to determine this point.

The project I would recommend for the improvement of the river is that of a channel 200 feet wide and 24 feet deep at low tide, the estimated cost of which is about $300,000.

STATEMENT OF TRADE OF THE POTOMAC RIVER.

The receipts and shipments by water at Washington and Georgetown for 1890 were as follows:

	Tons.
Coal	72, 089
Ice	135, 552
Lumber	69, 604
Sand	75, 000
Wood	48, 457
Miscellaneous	118, 994
Total	519, 696

This was carried in vessels as follows: Steamers of 5 to 10 feet draft, 696 arrivals; sail vessels drawing 10 to 20 feet, 491 arrivals; sail vessels drawing 4 to 10 feet, 1,572 arrivals; barges drawing 4 to 10 feet, 286 arrivals. Since the above statement a line of boats drawing 12 feet, aggregating about 350 arrivals, runs to Norfolk.

The receipts and shipments by water at Alexandria for 1890 were as follows:

	Tons.
By the steamboat lines, about	18,000
By coastwise and foreign vessels, about	60,000
Lumber trade, not included above, about	18,000
Total, about	96,000

This is carried by the same steamers that run to Washington, by sail vessels drawing 4 to 20 feet, and by barges. The number of vessels per annum drawing 15 to 20 feet is stated at about 25.

Total receipts and shipments for 1890, by water, at Washington, Georgetown, and Alexandria, is about 615,696 tons.

This comprises most of the trade of the river, except a small amount with Baltimore carried by steamboats and the oyster trade of the lower part of the river. The tonnage for 1892 and thereafter will probably be largely increased by the resumption of coal shipments from Georgetown which had been stopped by the damage done to the Chesapeake and Ohio Canal in 1889. In 1887 and 1888, before the injury to the canal, the coal shipments were about 264,927 tons and 240,836 tons, respectively.

The greater part of the tonnage of the river is carried by coastwise schooners drawing from 12 to 18 feet, the latter draft being about the limit which it is safe to carry over the bars. These vessels are usually towed in and out from below Kettle Bottom Shoals, a distance of about 80 miles. They carry ice from Maine, plaster from Nova Scotia, fertilizers, lumber, etc. When possible they load outward with coal at Georgetown.

In regard to future coal shipments, Mr. Winship, president of the Chesapeake and Ohio Canal Company, stated in effect as follows:

> The railroads from the coal beds to the east can not now carry enough coal to supply the demand. The shipments of coal from the Chesapeake and Ohio Canal are at present limited only by the number of boats on the canal. The capacity of the canal, with a sufficient number of boats for shipment, would be about 1,500,000 tons per year. The Cumberland coal fields are about 200 miles by canal and rail from Georgetown, or 185 miles by the Baltimore and Ohio Railroad, which will soon have a terminus in Georgetown, while the West Virginia and Virginia coal fields are about 400 miles from Norfolk and Newport News.
>
> The Chesapeake and Ohio Railroad and the Norfolk and Western Railroad are also both trying to establish lines to and terminal facilities in Georgetown. These facts all indicate an increase in future shipments by the Potomac River.
>
> In shipping by water the tendency is constantly toward vessels of greater tonnage, which are consequently of greater draft.
>
> Ten years ago the average size of vessels trading here was 400 tons; now it is 1,000 tons. A channel 24 feet deep would permit vessels carrying 3,000 tons to be used. Large vessels cost less per ton for building and sailing than small ones, consequently they can carry freight for a less price per ton. For this reason the construction of a deeper channel would lower the cost of freight per ton on such articles as are carried in deep draft vessels, viz, coal, plaster, ice, fertilizers, etc.

I transmit herewith a map* of the Potomac River from its mouth to Washington, D. C. The parts of the river to be improved are shown on an enlarged scale.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieutenant-Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

*Not reprinted; printed in House Ex. Doc. No. 33, Fifty-second Congress, first session.

REPORT OF MR. L. R. GRABILL, ASSISTANT ENGINEER.

WASHINGTON, D. C., *November 3, 1891.*

COLONEL: In compliance with your letter of instructions dated September 12, 1891, I proceeded on September 15 to make an examination of the shoals in the Potomac River where less than 24 feet of water is found, at the following localities, viz: (1) Mattawoman Shoal, off Mattawoman Creek, between Indian Head and Cockpit Point; (2) The shoals between Smiths Point and Maryland Point; and (3) Kettle Bottom Shoals, near Swan Point.

Kettle Bottom Shoals.—The survey was here confined to the channel along the north shore between Swan Point and Cob Point, where a natural channel 23 feet deep and more than 400 feet wide at the narrowest point now exists, whereas the ruling depth along the line of the channel now used is from 21 to 22 feet. The obstructions consist of what are called "oyster rocks," through which the natural course of the deepest water is tortuous. The north channel is said to have been in regular use up to about thirty years ago.

Cross sections 800 feet apart, supplemented by lines of diagonal soundings, were taken for a distance of 12,600 feet (2.4 miles). The average width cross-sectioned was 1,700 feet; the distance between soundings was 50 to 80 feet. A broken base line 11,995 feet long was measured, the lower end being on the tongue of land east of the mouth of Neals Creek and about 800 feet below the point. Four points on this line were marked by monuments of gas-pipe driven in the ground. The height of the low-water plane was referenced by a row of galvanized nails driven at 2 feet above low water in a pile on the upper and inner corner of Lancaster's Wharf. Comparatively little dredging is required to make a channel 24 feet deep. The work will consist in widening the present channel by cutting off the points of two bars. The material of the oyster lumps is mud mixed with shells, the shells being more numerous and the material harder for 2 or 3 feet deep at the surface. No difficulty was found in forcing an iron rod by hand to the required depth. The tidal currents along the shore are weak, but are very variable in direction, at times setting almost directly toward shore.

A boring was taken on a shoal in the present channel and the material was found to be the same as just stated for the lumps in the north channel. Some of these lumps are very small, even when very shoal, and close searching is required to find them with the lead. The one examined in the present channel was less than 100 feet across above the 20-foot curve, the least depth found on it being 17 feet.

Maryland Point Shoal.—This is a wide mud flat which extends from the eastern side of the river, in the bend just above Maryland Point, where the river becomes quite wide. Cross-sections 800 feet apart, beginning just below Lower Thoms Point were taken for a distance of 9,600 feet (1.8 miles) down the river, and diagonal lines between stations were also taken over the shoalest part of the bar. The distance between the soundings was from 50 to 80 feet. The average width covered by the cross-sections was about 2,200 feet. For locating the soundings, a base line 9,560 feet long was measured from near Maryland Point to a short distance below Lower Thoms Point, and three pipe monuments were driven to witness the triangulation points on the base line which could not be permanently marked.

The least channel depth found was 22 feet. Borings showed the material of the entire bar to be soft mud. The channel to be excavated through this shoal will require to be on a curved line, or on a broken line with two angles, in order to follow as nearly as may be the curve of the natural channel. The direction of the tidal current will necessarily be oblique to a part of the channel at all times. The velocity of the tide is something over 1 mile per hour. The length of the channel to be excavated for 24 feet depth will be from 8,000 to 9,000 feet, depending somewhat on its location.

Smiths Point Shoals.—The shoal below Smiths Point was the only one of these examined. Shoals exist at and just above the point also, the estimate for which was derived from the Coast Survey Charts.

Cross-sections 800 feet apart were taken from a point 1,200 feet below Clifton Beach Wharf for a distance of 8,000 feet or 1½ miles. The average width cross-sectioned was 2,000 feet. The distance between soundings was from 50 to 80 feet. A base line 8,700 feet long was measured, and two points on this line were permanently marked by pipe monuments. At one point (Station B) a pipe monument was set as a witness mark to the true point, which could not be permanently marked.

The least channel depth found was 23.2 feet. The length of channel requiring to be excavated is 4,800 feet at this shoal and about 5,000 feet at the shoals opposite and above the point. Penetration by borings was easy, showing soft mud with some sand. The direction of the tide is nearly parallel with the channel. No separate gauge mark was placed here. The gauge for this shoal and for Maryland Point Shoal was referenced by a bench-mark on the shore at the landing at Harrisons Cove. The

bench is cut in the root of a locust tree, 12 inches in diameter; its elevation is 9.24 feet above mean low water as found during the examination of the bar.

Mattawoman Shoal.—This shoal is formed at the junction of Occoquan Bay and of Mattawoman Creek with the Potomac, and lies just below the naval proving grounds at Indian Head. Probably the greater part of the material forming the bar comes out of Occoquan Creek at freshet periods.

Cross-sections, usually 500 feet apart, were taken from a point 2,000 feet below the Indian Head Wharf to 1,000 feet above Stump Neck Wharf, over a distance of 19,400 feet (about 3.7 miles). The average width cross-sectioned was about 4,000 feet. The distance between the soundings was about 80 feet. The soundings were located by means of a base line 9,428.5 feet in length along the shore above Deep Point. Station points were marked with pieces of gas-pipe, driven in the ground, at two points (A and B) on the base line, and at an auxiliary station on Free Stone Point. The stations at Stump Neck and at Deep Point were also well marked. The low-water height used for the survey is referenced by a bench on a locust tree at Stump Neck, 13.32 feet above the plane of low water, also by a bench cut on a walnut tree on the east shore of Mattawoman Creek, about 500 feet below a group of houses on a point; the elevation of the bench being 6.38 feet above low water.

The least channel depth was found to be 19.5 feet. The length of cut required to make a channel 24 feet deep through the bar is about 15,400 feet in a straight line. The course of the tides is about parallel with the channel, and the velocity about one mile per hour. Six borings were taken at different points. The bottom for about two miles at the upper end of the bar was found to be soft mud, and for about one mile at the lower end it was found to be mud mixed with sand, with gravel below the surface at some points. The cut can probably all be done with a clam-shell dredge.

Maintenance of channels.—It is certain that contracting works would keep the excavated channels at Maryland Point and at Mattawoman Shoal open longer than they will otherwise remain, since they will tend to fill again from the sides and with material deposited from the slack currents formed at these wide portions of the river. But it is a question, considering the draft of the greater number of the vessels likely to navigate the river, whether, in the localities where contracting works would require to be put, they would not offer too great an obstruction, and cost too much to be considered. The channel at Kettle Bottoms will probably remain open when once dredged.

Party, cost, etc.—The examination was completed on October 3, 1891. The steam launch *Nera* and two large rowboats were used, with 12 men, all told.

For further details, reference to the notes and maps of the bars may be made.

Very respectfully,

L. R. GRABILL,
Assistant Engineer.

J 15.

EXAMINATION AND SURVEY FOR BREAKWATER FOR HARBOR OF REFUGE IN LYNNHAVEN BAY, NEAR CAPE HENRY, AT FOOT OF CHESAPEAKE BAY, VIRGINIA.

[Printed in House Ex. Doc. No. 27, Fifty-second Congress, first session.]

UNITED STATES ENGINEER OFFICE,
Washington, D. C., November 12, 1891.

GENERAL: The act of Congress approved March 3, 1891, in relation to a breakwater at Lynnhaven Bay, is as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of War is hereby directed to cause examination and survey to be made, and the estimated cost of improvement to be estimated for a breakwater to form a harbor of safety and refuge in Lynnhaven Bay, near Cape Henry, at the foot of Chesapeake Bay, Virginia.

The survey was assigned to my charge by Department letter of March 12, 1891. The field work was intrusted to Frank P. Kellogg, assistant engineer.

The oldest reliable survey of Lynnhaven Bay that could be obtained was that made by the Coast Survey in 1853; the latest, that made in 1889. Copies of these were placed at my disposal through the courtesy of the superintendent, Mr. Mendenhall. The examinations made by Mr. Kellogg were conducted chiefly with a view to determining the velocity and direction of the currents at the various stages of ebb and flood tide, the character of the anchorage grounds to be covered by the proposed breakwater, the probable erosive action of the waves on the shore line, and whether any filling has taken place on the anchorage grounds of the bay.

Owing to the difficulty of working without a steamer, and the small amount of funds assigned for the work, the examination was not as thorough as it should be to locate with accuracy the proper site of a breakwater to form a harbor of refuge. Tidal observations were taken at a gauge established in Lynnhaven Creek for the entire month of August, with a view to determining the mean rise and fall. These observations show that during the month of August, 1891, the mean range of the tides was 1.73 feet. The extreme range was 3.1 feet. This differs considerably from that determined by the Coast Survey for April and May preceding, the mean range for those two months being 2.62 feet. The extreme height of storm tides will perhaps exceed ordinary high tide by about 3 feet.

The examinations show that there is good anchorage ground throughout a large area of the bay. A comparison of the different surveys shows that no perceptible change has taken place in the bottom, and but little change in the shore line. The law directing the survey has for its chief object the making of an estimate of the cost of the construction of a breakwater for a harbor of refuge, and sufficient data was obtained, it is believed, for that purpose.

The best location for such a work has only been determined approximately. Before the work of construction is undertaken a much more

extended survey would be necessary for the purpose of determining with greater accuracy the force and direction of the currents, the character of the bottom, the force, direction, and duration of the most severe storms, and the best location to be given the work in order to insure the maintenance of deep water at the anchorage, and not cause shoaling such as has taken place at the Delaware Breakwater.

The most violent storms come from the northwest and northeast. Judged from the records of the Signal Bureau, there appears to be but little, if any, difference in their duration and intensity, those from the northwest being quite as severe as those from the northeast. But for coasting vessels at sea a northwest wind is a fair one, and the sea is then comparatively smooth. Under ordinary circumstances a harbor is not needed in a northwest gale, but when the storm comes from the northeast or east the wind has the full sweep of the Atlantic Ocean. The waves attain their maximum height and velocity of movement. The land is then on the lee and a source of danger. It is then that a harbor of refuge is chiefly needed. It is no unusual sight in a northeast gale to see from 100 to 300 vessels at anchor in Hampton Roads, this being the nearest harbor.

It is reported that in the last thirteen years no less than one large ship, nine barks, one brig, four steamers, twenty-two schooners, and a large number of small craft engaged in the fishing and oyster trade have been lost or stranded on or near the shore of Lynnhaven Bay, the loss of these vessels and their cargoes being accompanied in some cases by loss of life. On February 3, 1886, the schooner *Anthea Godfrey* foundered in Lynnhaven Bay, and 11 persons were lost. March 18, 1889, the bark *E. M. Pettingill* also went to pieces with the loss of all on board. It would thus appear that a harbor of refuge at Lynnhaven Bay is demanded for humanity's sake no less than for commercial reasons.

The distance from an anchorage in Lynnhaven Bay to the usual anchorage in Hampton Roads is about 20 statute miles. Rather than run so far off his course the captain of a vessel will frequently keep the sea and take his chances, whereas if there was a harbor near by he would take advantage of it and ride out the gale at anchor. It is also to be remembered that in a northeast gale, the weather being generally thick, the entrance to Hampton Roads can not safely be made even in daytime without a pilot, and it is not always possible to get one. At night the entrance should not be attempted without a pilot, unless the master is familiar with it. It sometimes thus becomes necessary to anchor in Lynnhaven Bay, but the anchorage, though good to hold on to, is only protected on the south, a direction from which the severe storms do not come.

A harbor of refuge at Lynnhaven Bay would be of especial value to the barges in which more than half of the coal tonnage is moved from the Chesapeake north. After leaving Hampton Roads there is no suitable anchorage for such craft until Assateague is reached, and shelter here is denied to all but those of light draft.

It is not alone the commerce of Norfolk, Newport News, and Baltimore that will be benefited, though that is large, but all the coasting trade between Northern and Southern ports.

A breakwater to form a harbor of refuge at Lynnhaven Bay should be so located as to give shelter chiefly from northeast gales. At the same time it is desirable that it should also afford some cover from the northwest. I have therefore located the structure, which is to be un-

derstood as an approximate location only, as shown on the accompanying chart.* The easterly arm is made 3,000 feet in length, the westerly one 1,500 feet—a total length of 4,500 feet. This would give a safe harbor for a fleet of at least 300 vessels, and should it be found necessary in the future to increase the area of anchorage room, it can easily be done by lengthening either arm of the projected structure.

The cost of a breakwater is determined by the details of its construction, and in this respect there is great diversity in practice. It is sometimes built as a random pile of stones called riprap, the slopes to the sides being those that they will naturally take under the action of the waves. The Delaware Breakwater is a sample of this mode of construction. Another method of construction is to form a mound of riprap with from 12 to 22 feet of water at mean low tide over the upper surface as a foundation for a random pile of larger stones or concrete blocks. A third, is to form a mound as just described, and then lay concrete blocks on it in regular order so as to form a solid mass. A fourth, is to build up a solid mass of concrete or masonry from the bottom. The third method is the one most generally adopted in recent constructions, as it is the most economical under nearly all circumstances.

The depth of water at the site of the Delaware Breakwater does not differ materially from that at the site of the proposed breakwater in Lynnhaven Bay, and, as it has withstood the most severe storms for years without serious impairment, it may safely be assumed that a similar construction in Lynnhaven Bay would fulfill its object. The cost of the Delaware Breakwater, however, amounted to about $550 per linear foot, and a similar construction in Lynnhaven Bay would cost but little less.

I estimate the cost of a breakwater at Lynnhaven Bay, constructed in a manner similar to that in the Delaware, as follows:

Cost per linear foot.

123 tons of riprap stone below 12 feet depth, at $2.25	$276.75
74 tons of riprap stone above 12 feet depth, at $3.25	240.50
	517.25

If constructed of blocks of concrete thrown into a random pile similar to the mole of Algiers, the cost would be as follows:

Cost per linear foot.

102 tons riprap stone, at $2.25	$229.50
29 cubic yards concrete in blocks, at $7	203.00
	432.50

If constructed of concrete blocks of regular shape, laid close and bonded together, the mass being founded on a riprap base, as shown on the accompanying sheet,* the estimated cost would be as follows:

Cost per linear foot.

57 tons riprap stone, at $2.25	$128.25
11.1 cubic yards concrete in blocks, at $10	111.00
5.2 cubic yards concrete en masse, at $10	52.00
2.3 cubic yards concrete in bags, at $10	23.00
	314.25

*Not reprinted; printed in House Ex. Doc. No. 27, Fifty-second Congress, first session

There are numerous instances of breakwaters built in the form of the latter that have successfully stood the attacks of waves in places of greater exposure than that at Lynnhaven Bay, hence it may be considered perfectly safe to adopt that form of construction.

The entire estimated cost of such a breakwater, of the total length of 4,500 feet, as shown on the accompanying map, including 10 per cent for contingencies, is $1,555,538.

I would recommend the latter method of construction.

Very respectfully, your obedient servant,

PETER C. HAINS,
Lieut. Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers. U. S. A.

J 16.

ESTABLISHMENT OF HARBOR LINES IN ANACOSTIA RIVER (EASTERN BRANCH OF THE POTOMAC), AT WASHINGTON, DISTRICT OF COLUMBIA.

WASHINGTON, D. C., *February 15, 1892.*

SIR: The Commissioners of the District of Columbia have read with great interest the report of Col. P. C. Hains of a preliminary examination and survey of the Eastern Branch (Anacostia River) of the Potomac River.

In this report Col. Hains states that harbor lines should be established at an early day along the banks of this stream from its mouth to Bennings Bridge.

The Commissioners are continually required to report on projects for bridges across the Eastern Branch and for other matters that require the harbor lines to be considered. For this reason they respectfully request that these harbor lines be fixed at as early a date as possible, and hope that it may be convenient for the War Department to take up this matter very soon.

Very respectfully,

J. W. DOUGLASS,
President Board of Commissioners, District of Columbia.

Hon. STEVEN B. ELKINS,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 17, 1892.

Respectfully returned to the Secretary of War, with recommendation that a Board of Officers of the Corps of Engineers, to consist of Col. William P. Craighill, Lieut. Col. George H. Elliot, and Maj. C. E. L. B. Davis, be constituted, to consider and report upon the subject of harbor lines in the Anacostia River, Eastern Branch of the Potomac, from its mouth to Bennings Bridge; the Board to meet at Washington, D. C., upon the call of the senior member, and its expenses to be paid from appropriation for the Eastern Branch of the Potomac River—act September 19, 1890.

With the sanction of the Secretary of War the order constituting the Board will be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT, *February 19, 1892.*

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., May 16, 1892.

GENERAL: The Board of Engineers constituted by Special Orders No. 10, Headquarters, Corps of Engineers, February 20, 1892, has the honor to submit the following report upon the subject of harbor lines in the Anacostia River.

The order constituting the Board is as follows:

SPECIAL ORDERS No. 10.

HEADQUARTERS, CORPS OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 20, 1892.

By authority of the Secretary of War a Board of officers of the Corps of Engineers, to consist of Col. William P. Craighill, Lieut. Col. George H. Elliot, Maj. Charles E. L. B. Davis, will assemble at Washington, D. C., on the call of the senior member, to consider and report upon the subject of harbor lines in the Anacostia River (Eastern Branch of the Potomac) from its mouth to Bennings Bridge.

Upon the completion of the duty assigned Col. Craighill will return to his station.

The journeys required under this order are necessary for the public service.

By command of Brig. Gen. Casey:

JOHN G. D. KNIGHT,
Captain, Corps of Engineers.

The following letter addressed to the honorable the Secretary of War by the president of the Board of Commissioners of the District of Columbia was before the Board:

OFFICE OF THE ENGINEER COMMISSIONER, DISTRICT OF COLUMBIA,
Washington, D. C., February 15, 1892.

Hon. STEPHEN B. ELKINS,
Secretary of War:

SIR: The Commissioners of the District of Columbia have read with great interest the report of Col. P. C. Hains of a preliminary examination and survey of the Eastern Branch (Anacostia River) of the Potomac River.

In this report Col. Hains states that harbor lines should be established at an early day along the banks of this stream from its mouth to Bennings Bridge.

The Commissioners are continually required to report on projects for bridges across the Eastern Branch and for other matters that require the harbor lines to be considered. For this reason they respectfully request that these lines be fixed at as early a date as possible, and hope that it may be convenient for the War Department to take up this matter very soon.

Very respectfully,

J. W. DOUGLASS,
President Board of Commissioners, D. C.

The first meeting of the Board was held at Washington on March 8, 1892, and the weather being unfavorable for an examination of the Anacostia River the Board called upon the District Commissioners to learn their views upon the subject under consideration, the Board having been appointed in response to the letter of the president of the Board of Commissioners, quoted above.

Other meetings were held on the 10th and 16th of March, and on the latter date a preliminary report was submitted by the Board, to which attention is respectfully invited. In this preliminary report the Board was able to state definitely the particular point desired by the District Commissioners, namely, the width between the bulkhead lines at the Navy-Yard Bridge.

The attention of riparian owners was called by a notice in the public press to the fact that a board of engineer officers had been convened to consider and report upon the subject of harbor lines in the Anacostia River, and they were invited to submit their views in writing.

A letter was received from Mr. Thomas Blagden, owner of Blagden's Wharf, on Georgia avenue between Third and Fourth streets, SE., making inquiries as to the location of the harbor lines with reference to his wharf. He was informed that the proposed lines would pass considerably in front of the wharf.

This was the only communication received on the subject.

It was found that in order to describe the proposed harbor lines accurately by distances and courses certain points must be determined in addition to those on the chart. The necessary field work was protracted not only on account of unfavorable weather, but also because of the peculiarly difficult nature of the shore line, necessitating long detours at various points.

The following is the description of the pierhead and bulkhead lines which the Board recommends for adoption. These lines are shown on the accompanying tracing,* attached to and forming part of this report.

DESCRIPTION.

Wharf or pierhead line on the right of the channel.—Commencing at a point on the northerly side of the junction of the Washington Channel of the Potomac River with the channel of the Anacostia River, said point of commencement bearing S. 7° 18′ W. and being 827.3 feet distant from a stake† on the southwest corner of the United States arsenal reservation, said stake being marked C on the accompanying map, and running thence on a curve, concave to the channel of the Anacostia River, with a radius of 3,300 feet and a chord bearing N. 52° E. and 1,180 feet long to a pile on the southwest corner of the wharf at the southeast corner of the United States arsenal reservation, said pile being marked D on the map; thence on a curve, concave to the said channel, with a radius of 3,004 feet and a chord bearing N. 69° 19′ E. and 734.1 feet long; thence on a curve convex to the channel, with a radius of 3,000 feet and a chord bearing N. 71° 52′ E. and 467 feet long to a point on Buzzards Point bearing S. 87° 04′ W. and distant 159.1 feet from a stake marked E on the map; thence on a curve convex to the channel, with a radius of 1,650 feet and a chord bearing N. 50° 40′ E. and 950 feet long; thence on a curve convex to the channel, with a radius of 4,400 feet and a chord bearing N. 29° 42′ E. and 650 feet long; thence in a straight line N. 25° 28′ E. 660 feet; thence on a curve concave to the channel with a radius of 2,980 feet and a chord bearing N. 37° 5′ E. and 1,200 feet long; thence on a curve concave to the channel, with a radius of 2,050 feet and a chord bearing N. 80° 42′ E. and 2,172.6 feet long to a point bearing S. 51° 24′ E. and distant 109.5 feet from a stake on the SW. corner of the United States navy-yard reservation, marked K on the map; thence S. 67° 18′ E. 1,000 feet to a point bearing S. 22° 42′ W. and distant 30 feet from a stake near the southeast corner of the United

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* Omitted.

† This stake will be replaced by a stone monument in case these harbor lines are approved.

States navy-yard reservation and marked L on the map, the last-mentioned line being parallel to K L; thence on a curve convex to the channel, with a radius of 1,014 feet and a chord bearing S. 88° 51′ E. and 744.6 feet long; thence in a straight line N. 69° 36′ E. 153.3 feet more or less to westerly corner of the north abutment of the navy-yard bridge, the last-mentioned line being at right angles to the line of said bridge; thence N. 69° 36′ E. 400 feet; thence N. 53° 28′ E. 1,600 feet; thence N. 65° 54′ E. 1,401.3 feet; thence about N. 77° 03′ E. 686.2 feet more or less to a point on the center line of the Pennsylvania Avenue or Eastern Branch Bridge distant 528 feet from the center of the circle at the intersection of K street south with Seventeenth street east.

Bulkhead line on right of channel.—Between the east boundary of the United States arsenal reservation and the west boundary of the United States navy-yard the bulkhead line shall be parallel to and 200 feet inside the above-mentioned wharf lines. Between the east boundary of the navy-yard and the west line of Fourteenth street east the bulkhead line shall be parallel to and 100 feet inside the above wharf lines.

Bulkhead line on left side of channel.—Commencing at a point on the center line of the Pennsylvania Avenue or Eastern Branch Bridge, distant 1,574 feet from the center of the circle at the intersection of K street south with Seventeenth street east, and running thence S. 77° 03′ W. 1,281.9 feet; thence S. 65° 54′ W. 1,236.2 feet; thence S. 53° 28′ W. 1,626.3 feet; thence S. 69° 36′ W. at right angles to the line of the Navy-Yard Bridge about 513.4 feet to a point bearing S. 20° 24′ E. and distant 800 feet from the westerly corner of the north abutment of the said Navy-Yard Bridge; thence S. 69° 36′ W. 659 feet; thence on a curve concave to the channel with a radius of 1,270 feet and a chord bearing N. 88° 51′ W. and 932.8 feet long; to a point bearing S. 22° 42′ W. and distant 1,030 feet from a stake near the SE. corner of the United States navy-yard reservation marked L on the map; thence parallel to line L. K. on said map N. 67° 18′ W. 1,000 feet; thence on a curve convex to the channel with a radius of 1,050 feet and a chord bearing S. 80° 42′ W. and 1,112.8 feet long; thence on a curve convex to the channel with a radius of 1,980 feet and a chord bearing S. 37° 05′ W. and 797.4 feet long; thence in a straight line S. 25° 28′ W. 660 feet; thence on a curve concave to the channel with a radius of 5,400 feet and a chord bearing S. 29° 42′ W. and 797.7 feet long; thence on a curve concave to the channel with a radius of 2,650 feet and a chord bearing S. 50° 40′ W and 1,525.8 feet long; thence in a straight line S. 67° 24′ W. 700 feet; thence on a curve convex to the channel with a radius of 2,180 feet and a chord bearing S. 41° 24′ W. and 1,911.3 feet long; thence in a straight line S. 15° 24′ W. 1,905 feet more or less to the intersection of this line with high-water mark on Giesboro Point.

Wharf or pierhead line.—The wharf line on the left of the channel between the Pennsylvania Avenue Bridge and the line of east boundary of the navy-yard shall be parallel to and 100 feet outside the above-described bulkhead line. Between line of the east boundary of the navy-yard and Giesboro Point the wharf line shall be parallel to and 200 feet outside the above-described bulkhead line.

The order convening the Board directed that harbor lines be considered and reported upon from the mouth of the Anacostia River to Bennings Bridge, but as at present there is no commerce, except that of sand-scows, above the Pennsylvania Avenue Bridge, and can be none on the upper river until draw spans are inserted in this bridge and also in the trestle bridge of the Baltimore and Potomac Railroad, the Board has thought best to leave the subject of harbor lines above the Pennsylvania Avenue Bridge for future consideration, as such lines can be much more intelligently considered after the future has developed the needs of this particular locality.

Capt. Fieberger in his letter of March 14, 1892, attached to and forming part of the Board's preliminary report, says:

> Between Pennsylvania Avenue and Bennings Bridge no immediate improvements are contemplated, and the establishment of these lines might be postponed if your Board considers it advisable.

Another reason for this postponement is that a project has been reported upon for building an intercepting sewer to cross the Anacostia River by a siphon and to discharge into the Potomac River at a point below Alexandria. This project involves an estimated expenditure of about $4,000,000, and will probably be carried out eventually. In the meantime, about one-half of the sewage of the city of Washington is

discharged through the James Creek Canal into the Anacostia, and this will be continued until the intercepting sewer is built, the amount of sewage increasing with the growth of the city. It may therefore be a question for future consideration whether the low-lying flats above the trestle bridge should not be preserved for a flushing-basin to keep the river below as free from offense as possible until the new sewer system is completed, in which case bulkhead lines would be very differently located from those intended merely to conserve the interests of navigation.

All of which is respectfully submitted.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
GEORGE H. ELLIOT,
Lieut. Colonel, Corps of Engineers.
CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 19, 1892.

Respectfully submitted to the Secretary of War.

It being made manifest to the Secretary of War that the establishment of harbor lines is essential to the preservation and protection of Anacostia River (Eastern Branch of the Potomac) a Board of Engineers was constituted by special orders from Headquarters, Corps of Engineers, to consider and report upon this subject, and the report of the Board recommends for approval of the Secretary of War the harbor lines described in the within report and delineated upon the accompanying tracing.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineer

[Second indorsement.]

WAR DEPARTMENT, *May 21, 1892.*

The harbor lines described in the within report and delineated on the accompanying tracing are approved.

S. B. ELKINS,
Secretary of War.

APPENDIX K.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN SOUTHEASTERN VIRGINIA AND NORTHEASTERN NORTH CAROLINA.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor of Norfolk and its approaches, Virginia.
2. Approach to Norfolk Harbor and the United States Navy-yard at Norfolk, Va.
3. Hampton Creek and Bar, Virginia.
4. Nansemond River, Virginia.
5. Chickahominy River, Virginia.
6. Appomattox River, Virginia.
7. Inland water route from Norfolk Harbor, Virginia, to Albermarle Sound, North Carolina, through Currituck Sound.
8. North Landing River, Virginia and North Carolina.

HARBOR LINES.

9. Modification of harbor lines in South Branch of Elizabeth River at the Navy-yard, Norfolk, Va.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., July 8, 1892.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1892, upon the works of river and harbor improvement in my charge.

Very respectfully, your obedient servant,

EDW. BURR,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

K 1.

IMPROVEMENT OF HARBOR OF NORFOLK AND ITS APPROACHES, VIRGINIA.

The river and harbor act of September 19, 1890, contained the following provisions:

Improving harbor at Norfolk and its approaches, Virginia; continuing improvement $150,000, $50,000 of which shall be expended in improving the approach to the inner harbor and the United States navy-yard at Norfolk by increasing anchorage between Lambert Point and Fort Norfolk.

Under this appropriation a contract was entered into March 13, 1891, with the National Dredging Company of Wilmington, Del., to remove about 1,260,000 cubic yards of material, at 10.7 cents per cubic yard, the contract to be completed before May 31, 1892. Work was commenced by this company on April 2, 1891, and completed May 14, 1892.

During the fiscal year ending June 30, 1892, the contractors excavated 991,704 cubic yards and redeposited it to the east of Willoughby Spit, Hampton Roads, the length of tow varying from 5 to 15 miles. The total amount removed under this contract was 1,264,726 cubic yards, including 273,022 cubic yards removed during the previous fiscal year.

Of the amount removed during the year 233,756 cubic yards were from the bar at Sewells Point, increasing the width of the channel from 350 feet to 500 feet, with a least depth of 25 feet at ordinary low water; 279,114 cubic yards were from the Eastern Branch, the bar at the mouth being redredged to a depth not less than 22 feet, and a part of the Berkley Flats, 240 feet wide and 1,400 feet long, being dredged to a depth of 16 feet; 478,834 cubic yards were from the anchorage and channel at the mouth of the Western Branch, producing 32 acres of the proposed anchorage, and making more available 17 acres requiring no dredging.

After completing the dredging under this contract examinations were made of the dredged channels. These examinations showed that the channels at Sewells Point and in the Eastern Branch were in good condition, and that the channel at the mouth of the Western Branch had the same depth on it as in 1889.

APPROPRIATIONS.

August 14, 1876	$35,000
June 18, 1878	50,000
March 3, 1879	75,000
June 14, 1880	50,000
March 3, 1881	75,000
August 2, 1882	75,000
July 5, 1884	25,000
August 5, 1886	50,000
August 11, 1888	50,000
September 19, 1890	150,000

Money statement.

July 1, 1891, balance unexpended	*$136,315.20
June 30, 1892, amount expended during fiscal year	130,526.90
July 1, 1892, balance unexpended	5,788.30
July 1, 1892, outstanding liabilities	45.75
July 1, 1892, balance available	5,742.55
Amount appropriated by act approved July 13, 1892	150,000.00
Amount available for fiscal year ending June 30, 1893	155,742.55
Amount (estimated) required for completion of existing project	307,744.56
Amount that can be profitably expended in fiscal year ending June 30, 1894	191,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* The difference in this amount and the amount stated in Annual Report for 1891, is due to an error of $30.84 in that report.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, NORFOLK, VA., *May 14, 1892.*

SIR: Inclosed please find statement of imports and exports for the year ending January 1, 1892.

Very respectfully,

R. G. BANKS,
Collector.

Lieut. EDWARD BURR, U. S. A.

Statement of imports and exports for year ending January 1, 1892.

IMPORTS.

Articles.	Quantity.	Value.
Kainit		$20,360
Oil		10,825
Creosote		8,501
Salt		6,924
Wine		163
Miscellaneous		11,517
Total		58,290

EXPORTS.

Cotton ... bales	262,285	$11,835,596
Coal ... tons	153,214	476,320
Corn ... bushels	83,617	48,125
Wheat ... do	1,492,024	1,590,577
Rye ... do	63,787	57,884
Oats ... do	210,720	83,597
Flour ... barrels	100,356	495,104
Cotton-seed meal		7,837
Cattle ... head	1,228	91,010
Tobacco ... pounds	958,515	67,976
Bark ... bags	2,933	3,000
Oars	476,320	3,250
Lumber		332,954
Staves		148,671
Phosphate rock		20,625
Apples		2,945
Miscellaneous		3,623
Total		15,269,094

Navigation.

Direction.	Vessels cleared.		Vessels entered.	
	No.	*Tons.*	*No.*	*Tons.*
Foreign	499	672,197	94	116,926
Coastwise	1,328	1,286,521	1,582	2,042,257
Total	1,827	1,958,718	1,676	2,159,183

LETTER OF MR. NORMAN BELL, SUPERINTENDENT AND SECRETARY, NORFOLK AND PORTSMOUTH COTTON EXCHANGE.

NORFOLK, VA., *June 14, 1892.*

DEAR SIR: In response to your courteous request herewith please find statement of the receipts and shipments of cotton at the port of Norfolk for the year ending December 31, 1891:

	Bales.
Total receipts cotton at Norfolk, twelve months ending December 31, 1891	626, 762
Stock on hand December 31, 1890	59, 046
Exported:	
Great Britain, France, and continent	260, 134
Coastwise shipments, overland and inland	359, 965
Total shipments	620, 099
Stock on hand December 31, 1891	65, 709
Total	685, 808

On the basis of 494.24 pounds to the bale, which is the average weight of bales exported December 31, 1891, the total shipments amount to 136,820 tons.

I remain, dear sir, yours, very truly,

NORMAN BELL,
Superintendent and Secretary.

Lieut. EDWARD BURR, U. S. A.

Statement of Pocahontas coal consigned to William Lamb & Co., agents at Lambert Point, in the year 1891.

Steamers:	
Bunkers	479
Cargo and bunkers	34
	513
Barkentine	1
Ocean tugs and barges	642
Schooners	538
Total vessels	1. 694
Foreign ... tons	27, 997
Coastwise ... do	1, 196, 248
Steamers ... do	135, 112
Ocean tugs ... do	18, 780
Local ... do	90, 606
Total	1, 468, 743

Tabular statement of value of exports and imports and number and tonnage of vessels registered at the port of Norfolk, Va.

Year ending January 1.	Foreign vessels. Entered. No.	Foreign vessels. Entered. Tons.	Foreign vessels. Cleared. No.	Foreign vessels. Cleared. Tons.	Coastwise vessels. Entered. No.	Coastwise vessels. Entered. Tons.	Coastwise vessels. Cleared. No.	Coastwise vessels. Cleared. Tons.	Exports.	Imports.
1883	64	29, 572	135	112, 529	1, 314	1, 248, 461	818	1, 099, 266	$18, 201, 759	$167, 157
1884	96	69, 421	156	110, 450	1, 257	1, 003, 920	880	996, 062	12, 351, 672	223, 676
1885	66	70, 711	127	102, 821	1, 330	1, 078, 484	1, 450	1, 275, 477	14, 797, 046	128, 372
1886	82	67, 168	159	141, 913	1, 398	1, 215, 398	1, 555	1, 334, 557	11. 646, 907	127, 391
1887	73	73, 896	208	207, 428	1, 432	1, 261, 365	1, 719	1, 432, 016	14, 393, 337	99, 958
1888	66	59, 805	212	234, 644	1, 344	1, 360, 633	1, 474	1, 354, 620	12, 381, 122	99, 584
1889	51	64, 975	227	256, 351	1, 328	1, 286, 573	1, 402	1. 290, 013	13, 865, 586	176, 253
1890	70	80, 887	288	335, 021	996	1, 265, 470	1, 302	1, 230, 189	12, 828, 641	166, 958
1891	81	83, 341	397	463, 216	1, 169	1, 140, 625	1, 504	1, 546, 235	15, 096, 634	94, 487
1892	94	116, 926	499	672, 197	1, 582	2, 042, 257	1, 827	1, 958, 718	15, 269, 094	58, 290

Approximate amount of freight of all kinds received and shipped by water.

	Tons.
1888	1,914,506
1889	2,243,087
1890	2,384,841
1891	2,931,751

K 2.

IMPROVEMENT OF APPROACH TO NORFOLK HARBOR AND THE UNITED STATES NAVY-YARD AT NORFOLK, VIRGINIA.

The object of this improvement is to secure a channel 700 feet wide and 25 feet deep at ordinary low water by dredging and the construction of a dike.

The desired channel was secured in July, 1889, since which time no dredging has been done. A survey made in May, 1891, indicated little, if any, shoaling of the dredged channel. A survey of May, 1892, shows some shoaling on the east side of the channel. That this shoaling is due to natural causes is doubtful, and to be determined by later examinations.

It is not probable that the dike will be necessary for the maintenance of the channel, and the money estimated for it could be more advantageously expended in removing the shoal lying in front of and below the piers at Lambert Point on the east side of the channel.

There was expended on this improvement during the year ending June 30, 1892, $861.57, which was applied to surveys, office expenses, etc.

For commercial statistics see report on improvement of harbor of Norfolk and its approaches:

APPROPRIATIONS.

July 5, 1884	$50,000
August 5, 1886	137,500
August 11, 1888	10,000

Money statement.

July 1, 1891, balance unexpended	$861.57
June 30, 1892, amount unexpended during fiscal year	861.57
Amount (estimated) required for completion of existing project	108,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

K 3.

IMPROVEMENT OF HAMPTON CREEK AND BAR, VIRGINIA.

This river is a tidal stream which empties into Hampton Roads about 2 miles from Fort Monroe. It is navigable for vessels drawing 11 feet at high water as far as the public wharf, Hampton, about 1 mile from its mouth.

Before 1879 the channel in the river was 60 feet wide and 8 feet deep

at low water; over the bar the depth was somewhat less. In 1879 and 1880 the Government dredged a channel 150 feet wide and 9 feet deep as far as the public wharf. In 1889 this channel was examined and found in good condition; it was therefore recommended that the channel be widened to 200 feet in the creek, and from 200 to 300 feet over the bar.

The necessary appropriation was made for this work in the river and harbor act of September 19, 1890. A project for its expenditure was accordingly submitted to the Chief of Engineers and received his approval. In accordance therewith a careful survey was made of the river and proposals invited for dredging. On March 20, 1891, a contract was entered into with the Atlas Dredging Company, to do the work for 11 cents per cubic yard. This contract was to be begun on or before January 1, 1892, and completed in 4 months.

Work was commenced under this contract in December, 1891, and completed in February, 1892. Eighty-four thousand three hundred and twenty-one cubic yards were dredged and redeposited east of Willoughby Spit in Hampton Roads. Through the bar the channel was increased in width to 300 feet and in the creek to 200 feet in width for a distance of about 2,400 feet, and to 160 feet in width for a farther distance of about 1,200 feet, or to the head of navigation. The depth obtained was 9 feet at ordinary low water.

An examination made since completing the contract shows the improvement to be satisfactory.

During the fiscal year ending June 30, 1892, $9,872.74 were expended on this improvement and applied to payments on contract, surveys and office expenses. The total expenditures to that date have been $22,000.

The improvement of this creek receives its importance from the fact that along its banks are the town of Hampton, the Hampton Industrial School, and the National Soldiers' Home. Most of the supplies for these places are received by water.

A daily line of steamers runs between Hampton and Norfolk, and a weekly line between Hampton and Baltimore.

A very full report of the commerce of Hampton is given in the report of Chief of Engineers for 1889, page 975, since which time there has been no appreciable change.

APPROPRIATIONS.

June 18, 1878	$10,000
March 3, 1879	2,000
September 19, 1890	10,000

Money statement.

July 1, 1891, balance unexpended	* $9,872.74
June 30, 1892, amount expended during fiscal year	9,872.74

K 4.

IMPROVEMENT OF NANSEMOND RIVER, VIRGINIA.

The object of this improvement is briefly to secure a 12-foot low water channel from Suffolk to Hampton Roads.

* The difference in this amount and the amount stated in last Annual Report as the balance unexpended July 1, 1891, is due to error of $10.10 in amount expended in fiscal year June 30, 1891, which should have been $127.26 instead of $117.16.

The river and harbor act of September 19, 1890, appropriated $10,000, for this work. A project for its expenditure was submitted to the Chief of Engineers and approved. In accordance therewith proposals were invited for dredging and on April 4, 1891, a contract was entered into with the Alabama Dredging and Jetty Company of Mobile, Ala., to do the work for 20 cents per cubic yard. Work on this contract was to have been completed on June 30, 1892, but on that date the work had not yet been commenced. Upon the application of the contractor an extension of sixty days to the time of completion of contract was granted June 28, 1892.

The amount expended on this work during the fiscal year ending June 30, 1892, was $41.50 and applied to office expenses.

APPROPRIATIONS.

March 3, 1873	$15,000
June 23, 1874	10,000
March 3, 1875	5,000
August 14, 1876	5,000
June 18, 1878	2,000
August 11, 1888	10,000
September 19, 1890	10,000

Money statement.

July 1, 1891, balance unexpended	$11,415.67
June 30, 1892, amount expended during fiscal year	41.50
July 1, 1892, balance unexpended	11,374.17
July 1, 1892, amount covered by uncompleted contracts	9,700.00
July 1, 1892, balance available	1,674.17
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	11,674.17
Amount (estimated) required for completion of existing project	122,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	32,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The shipments on this river are principally farm products, lumber, etc. Full statistics could not be gotten for the year 1891, although an effort was made to do so. If full shipments of the lumber had been furnished the tonnage would have shown an increase instead of a decrease for 1891.

Approximate amount of freight of all kinds received and shipped by water.

	Tons.
1888	109,900
1889	217,738
1890	117,896
1891	78,572

K 5.

IMPROVEMENT OF CHICKAHOMINY RIVER, VIRGINIA.

The object of this work is to secure a channel 11 to 12 feet deep at high water from Windsor Shades, the head of navigation, to the mouth of the river, a distance of 25 miles.

In January, 1891, an examination was made of all the work hitherto done with a view to determining the permanency of the dredged channels and the portions of the river in most need of improvement.

Very little shoaling was found to have taken place in the channels dredged since 1878; the worst shoals are those near Old Fort, which have a minimum depth of 9 to 10 feet high water and a minimum width of 40 to 50 feet.

A project for the improvement of these shoals by dredging, under the appropriation of September 19, 1890, was submitted to the Chief of Engineers and approved. In accordance therewith proposals were invited and on March 24, 1891, a contract was entered into with Chester T. Caler to do the work for 15½ cents per cubic yard.

Work under this contract was begun and completed in April, 1892, 13,000 cubic yards of material being removed and redeposited.

The channel at Binn Bar was dredged 60 feet in width for a length of 1,000 feet. At Osborne Bar the channel width was increased from 30 feet to 60 feet for a length of 570 feet. At Old Fort Bar the channel was dredged 80 feet wide for a length of 550 feet and a point below the bar, 50 feet by 150 feet, was removed. At Windsor Shades Bar a channel 40 feet wide was dredged, 1,400 feet long. All dredging was to not less than 9 feet at ordinary low water.

APPROPRIATIONS.

June 13, 1878	$5,000
March 3, 1879	1,000
June 14, 1880	2,000
March 3, 1881	2,000
August 2, 1882	5,000
August 5, 1886	4,000
August 11, 1888	2,500
September 19, 1890	2,500

Money statement.

July 1, 1891, balance unexpended	$2,409.02
June 30, 1892, amount expended during fiscal year	2,221.71
July 1, 1892, balance unexpended	187.31
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,187.31

COMMERCIAL STATISTICS.

The shipments on this river are principally farm products, lumber, railroad ties, etc. During the year 1891, these were—

Articles.	Quantity.	Value.
Pine wood .... cords..	60,000	$180,000
Lumber .... feet..	3,000,000	300,000
Railroad ties .... number..	59,000	175,000
Wheat .... bushels..	5,000	5,000
Corn .... do....	10,000	6,000
Merchandise		100,000

Approximate amount of freight of all kinds received and shipped by water.

	Tons.
1890	40,135
1891	53,652

K 6.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

The improvement of this river was continued under the project for the expenditure of the appropriation of $15,000 of the act of September 19, 1890. The details of this project are contained in the Annual Report of June 30, 1891, and included work both by contract and by hired labor.

Of the contract work, 18 jetties in the south channel were completed by July 4, 1891. This work included 1,730 feet of wattle work, 360 feet of sheet piling, and 18 mats weighted with gravel. The channel width was reduced to 200 feet for a length of 3,500 feet. The remainder of the contract work was completed September 4, 1891, and included 892 feet of brush and pile dikes in Magazine Bend, and at the lower end of Lieutenant Run Dike; 583 feet of Lieutenant Run Dike was backed up with brush to replace rotten sheet piling.

The work by hired labor included building a dam at Steins Cut, strengthening the closure dike at head of Puddledock Cut, and refilling with brush such dikes as showed settlement.

The Steins Cut Dam is 80 feet long, 8 feet high, and 10 feet wide on top, built of earth, gravel, and brush.

Behind the closure dike throughout its entire length was placed a bank of gravel and brush, raised above ordinary freshet height. The length of this bank was 1,823 feet; top width 10 feet, least fill 4 feet, and greatest fill 15 feet. Seven thousand, eight hundred and sixty-seven cubic yards of gravel were used.

Some damage was done to the new work by winter freshets. These freshets also caused shoaling on these bars at the lower end of Puddledock Cut and on Magazine Bend. Authority was obtained June 3, 1892, for their removal by hired labor, the use of Government plant, and the hire of the dredge belonging to the city of Petersburg, Va. Dredging was commenced June 29, 1892, and is now in progress.

APPROPRIATIONS.

March 3, 1871	$50,000
June 10, 1872	40,000
March 3, 1873	30,000
June 23, 1874	30,000
March 3, 1875	30,000
August 14, 1876	30,000
June 18, 1878	30,000
March 3, 1879	20,000
June 14, 1880	20,000
March 3, 1881	20,000
August 2, 1882	35,000
July 5, 1884	25,000
August 5, 1886	18,750
August 11, 1888	15,000
September 19, 1890	15,000

Money statement.

July 1, 1891, balance unexpended	*$11,420.46
June 30, 1892, amount expended during fiscal year	7,258.09
July 1, 1892, balance unexpended	4,162.37
July 2, 1892, outstanding liabilities	231.70
July 1, 1892, balance available	3,930.67
Amount appropriated by act approved July 13, 1892	15,080.00
Amount available for fiscal year ending June 30, 1893	19,010.67

COMMERCIAL STATISTICS.

[Furnished by Mr. W. E. Morrison, port warden.]

Statement of number and tonnage of vessels and value of freight shipped and received at Petersburg, Va.

Years ending—	No.	Tonnage.	Value of freights.		
			Shipped.	Received.	Total.
July 1, 1881	645	35,967	$74,724	$412,642	$487,366
1882	917	43,961	79,154	519,209	598,363
1883	980	46,070	181,763	569,876	751,639
1884	924	46,050	196,458	312,472	808,930
1885	893	40,669	230,508	529,786	760,294
1886	953	68,835	192,053	474,250	666,303
1887	836	63,169	104,923	304,425	409,348
1888	599	30,079	143,673	372,112	515,785
1889	595	27,981	132,072	270,031	402,103
Jan. 1, 1890	598	29,229	184,596	323,256	507,852
1891	621	35,219	425,887	280,254	706,141
1892	627	40,084	313,317	330,786	644,103

Approximate amount of freight of all kinds received and shipped by water.

	Tons.
1888	30,626
1889	26,121
1890	21,693
1891	26,275

K 7.

IMPROVEMENT OF INLAND WATER ROUTE FROM NORFOLK, VIRGINIA, TO ALBEMARLE SOUND, NORTH CAROLINA, THROUGH CURRITUCK SOUND.

This route, for the improvement of which the river and harbor act of September 19, 1890, contained an item of $10,000, is composed of several waterways, which have been separately under improvement.

The Elizabeth River, 11.9 miles long, was under improvement between

* The difference in this amount and the amount stated in Annual Report for 1891, unexpended July 1, 1891, is due to an error of 45 cents in that report of the amount expended June 30, 1891.

1873 and 1878. At a cost of $40,180 a channel 60 feet wide and 8 feet deep at low water was secured.

The North Landing River, 17 miles long, was under improvement between 1879 and 1887. At a cost of $49,777.34 a channel 80 feet wide and 9 feet deep was secured.

Currituck Sound, Coanjok Bay, and North River Bar, 13½ miles, were under improvement between 1879 and 1890. At a cost of $141,656.16 a channel 80 feet wide and 9 feet deep was secured through the sound, and a channel of the same depth 40 feet wide through the bay and over the bar.

The project adopted for the entire route is a channel 80 feet wide and 9 feet deep at low water to correspond to that already secured over nine-tenths of the route.

March 24, 1891, a contract for dredging was entered into with Chester T. Caler of Norfolk, Va., at 24¾ cents per cubic yard. Work was begun under this contract in December, 1891, and completed in March, 1892, 32,308 cubic yards being removed.

The dredging was done in the Elizabeth River, beginning at the Albemarle and Chesapeake Canal Lock and working down stream. Nine shoals, having a total length of 7,950 feet, were dredged to not less than 9 feet deep for a channel not less than 50 feet wide. Another shoal 600 feet long was dredged 25 feet wide and a width of 50 feet was removed from a point of shoal.

APPROPRIATIONS.

For South Branch, Elizabeth River, Virginia:	
March 3, 1873	$15,000
June 23, 1874	10,000
March 3, 1875	5,000
August 14, 1876	5,000
June 18, 1878	5,000
For North Landing River, Virginia and North Carolina:	
March 3, 1879	25,000
June 14, 1880	15,000
March 3, 1881	7,500
August 2, 1882	8,000
For Currituck Sound, Coanjok Bay, and North River Bar, North Carolina:	
June 18, 1878	20,000
March 3, 1879	25,000
June 14, 1880	25,000
March 3, 1881	30,000
August 2, 1882	20,000
July 5, 1884	5,000
August 5, 1886	10,000
August 11, 1888	7,500
For inland water route, etc.:	
September 19, 1890	10,000

Money statement.

July 1, 1891, balance unexpended	$9,480.96
June 30, 1892, amount expended during fiscal year	8,742.39
July 1, 1892, balance unexpended	738.57
Amount appropriated by act approved July 13, 1892	9,000.00
Amount available for fiscal year ending June 30, 1893	9,738.57
Amount (estimated) required for completion of existing project	49,677.08
Amount that can be profitably expended in fiscal year ending June 30, 1894	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[From records of Albemarle and Chesapeake Canal Company.]

Number, class, and tonnage of vessels passing through the inland water route from Norfolk Harbor to Albemarle Sound, North Carolina.

Year ending—	Steamers.	Schooners.	Barges.	Lighters.	Sloops.	Rafts.	Tonnage.
June 30, 1885	2,976	1,059	633	133	204	181	....
1886	3,271	1,082	549	55	178	244	336,737
1887	3,369	1,216	568	49	181	297	358,111
1888	3,862	1,362	361	44	265	378	435,745
1889	4,065	1,539	683	82	352	352	445,237
Jan. 1, 1890	4,169	1,699	878	67	446	335	454,950
1891	4,068	1,817	1,000	113	394	350	455,442
1892	4,061	1,804	1,150	62	329	298	467,113

Approximate amount of all kinds of freight passing through this route.

	Tons.
1888	335,758
1889	372,617
1890	403,111
1891	328,609

Two new lines of steamers between Norfolk and North Carolina points via this route were established during the year, but the most noticeable change has been in the substitution for sailing vessels of barges with larger carrying capacity.

K 8.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

The object of this improvement is to secure a channel 9 feet deep and 80 feet wide from North Landing Bridge to Ferraby Island, Currituck Sound.

The project was completed June 30, 1884, since which time the operations have consisted in removing logs abandoned by rafts. These were last removed in December, 1889, and January, 1890, since which time no work has been required.

The only operations contemplated for the present are removal of obstructions. The balance on hand will suffice, and no further appropriation is necessary.

This river forms part of the inland water route from Norfolk to Albemarle Sound.

For map, see Annual Report of the Chief of Engineers for 1889, page 962.

For commercial statistics, see report on "Inland water route, etc."

The appropriations for this river have been—

March 3, 1879	$25,000
June 14, 1880	15,000
March 3, 1881	7,500
August 2, 1882	8,000

Money statement.

July 1, 1891, balance unexpended	$2,665.31
July 1, 1892, balance unexpended	2,665.31

K 9.

MODIFICATION OF HARBOR LINES IN SOUTH BRANCH OF ELIZABETH RIVER AT THE NAVY-YARD, NORFOLK, VIRGINIA.

CIVIL ENGINEER'S OFFICE, NAVY-YARD,
Norfolk, Va., June 13, 1892.

SIR: I respectfully forward herewith a tracing * from the map showing the harbor lines as fixed by a board of officers from the Corps of Engineers, and approved by the Secretary of War,† showing the lines adjacent to the navy-yard.

Upon examination of these lines it will be seen that the project of extending the quay wall south of the entrance to the Timber Basin can not be carried out as originally designed unless a modification of the lines may be had at this point. In blue is shown the plans as fixed upon, and this plan should be carried out in order that a wharf with sufficient frontage may be had between the corner of the wall at the Timber Basin and the angle where direction is changed.

Very respectfully, your obedient servant,

U. S. G. WHITE,
Civil Engineer, U. S. N.

Commodore A. W. WEAVER, U. S. N.,
Commandant.

Respectfully submitted to the chief of Bureau of Yards and Docks.

A. W. WEAVER,
Commodore, Commandant.

BUREAU OF YARDS AND DOCKS, NAVY DEPARTMENT,
June 15, 1892.

Respectfully referred to the Secretary of the Navy, with request that the honorable Secretary of War may be asked to modify the harbor lines as fixed by a board of U. S. Army officers from the Corps of Engineers, and approved by the Secretary of War May 9, 1890, in order to meet the wants of the United States navy-yard, Norfolk, as set forth in the accompanying letter and plan submitted by the commandant of the yard.

N. H. FARQUHAR,
Chief of Bureau.

NAVY DEPARTMENT, *June 21, 1892.*

Respectfully referred to the honorable the Secretary of War, who is requested to modify the harbor lines as fixed by a board of U. S. Army officers from the Corps of Engineers, and approved by the Secretary of War May 9, 1890, in order to meet the wants of the United States navy-yard, Norfolk, as set forth in the accompanying letter and plan submitted by the commandant of the yard, and as recommended by the Bureau of Yards and Docks.

JAMES R. SOLEY,
Acting Secretary of the Navy.

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* Omitted.

† See Annual Report, Chief of Engineers, 1890, page 1032.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 27, 1892.

Respectfully returned to the Secretary of War.

The Navy Department requests modification of established harbor lines in South Branch of Elizabeth River at the Norfolk navy-yard.

The modification proposed is shown in blue on the accompanying tracing, and is recommended for approval.

THOS. LINCOLN CASEY,
Brigadier-General, Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *June 30, 1892.*

The modification of the harbor lines as delineated on the inclosed tracing is approved.

The honorable the Secretary of the Navy has been advised of this action.

J. M. SCHOFIELD,
Major-General, Acting Secretary of War.

APPENDIX L.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN VIRGINIA, NORTH CAROLINA, AND SOUTH CAROLINA.

REPORT OF MAJOR W. S. STANTON, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Staunton River, Virginia.
2. Roanoke River, North Carolina.
3. Pasquotank River, North Carolina.
4. Mackeys Creek, North Carolina.
5. Ocracoke Inlet, North Carolina.
6. Fishing Creek, North Carolina.
7. Pamlico and Tar River, North Carolina.
8. Contentnia Creek, North Carolina.
9. Trent River, North Carolina.
10. Neuse River, North Carolina.
11. Inland waterway between Newbern and Beaufort, North Carolina.
12. Harbor at Beaufort, North Carolina.
13. Inland waterway between Beaufort Harbor and New River, North Carolina.
14. Waterway between New River and Swansboro, North Carolina.
15. New River, North Carolina.
16. North East (Cape Fear) River, North Carolina.
17. Black River, North Carolina.
18. Cape Fear River, North Carolina, above Wilmington.
19. Cape Fear River, North Carolina, at and below Wilmington.
20. Lockwoods Folly River, North Carolina.
21. Yadkin River, North Carolina.
22. Harbor at Georgetown, South Carolina.
23. Winyaw Bay, South Carolina.
24. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., July 9, 1892.

GENERAL: I have the honor to transmit herewith Annual Reports for the fiscal year ending June 30, 1892, upon the works of river and harbor improvement under my charge during the last six months of that year.

Very respectfully, your obedient servant,

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

L 1.

IMPROVEMENT OF STAUNTON RIVER, VIRGINIA.

The improvement has been restricted to two sections, where it was most feasible, separated by an interval of 20½ miles, and aggregating 65 miles in length.

LOWER SECTION.

The lower section begins at Randolph, 24 miles above the confluence with the Dan (forming the Roanoke), and extends up 31½ miles to Brook Neal. "It is from 260 to 500 feet wide, with banks 12 to 22 feet high, and subject to freshets of from 30 to 43 feet height."

Its improvement was commenced in 1879. It then had "an average slope of 1.2 feet per mile, and a general channel depth of 4 to 5 feet at low water except at about 18 rock ledges or shoals where it was only about 1 to 2 feet at low water," and it "was then navigated by bateaux at all times and at mean winter water by one steamer of 14 inches draft."

The project of 1879, continued without modification, proposed to secure a bateaux channel-way 35 feet wide, 2 feet deep at low water, and of not over 10 feet slope per mile for the 31½ miles from Randolph to Brook Neal.

When work ceased, under charge of Mr. S. T. Abert, United States agent, October 18, 1889, the proposed navigation had been obtained for 29½ miles of its middle portion, and the section of 31½ miles from Randolph to Brook Neal had a fairly cleared channel for steamers of 2 feet draft and about 25 tons burden.

The whole amount expended separately for the improvement of this section is $37,500.

UPPER SECTION.

The upper section begins at the Virginia Midland Railroad bridge, 76 miles above the confluence with the Dan, and extends up 23½ miles to Pig River. "It is about 150 to 300 feet wide and subject to freshets of from 20 to 30 feet height."

Its improvement was commenced in 1883. It then had "an average slope of 4.3 feet per mile and a general channel depth of over 2 feet at ordinary stages of water, except at about 30 rock shoals where it was only 0.4 feet," and it "was then navigated by 8 bateaux of 20 inches draft, each about 12 tons."

The project of 1883, as modified in 1884 and 1887, proposed to secure "a bateaux channel-way of 14 feet breadth and 1½ feet depth at low water" over the entire section.

When work ceased, under charge of Mr. S. T. Abert, United States agent, September 18, 1888, the proposed navigation had been obtained for 18½ miles above the Virginia Midland Railroad bridge, making navigation for pole boats fairly good over the entire section up to Pig River.

The whole amount expended separately for the improvement of this section is $7,000.

No work has been done upon the improvement of either section since the dates above given.

The following letter by Capt. Bixby, Corps of Engineers, at its date in charge of the improvement, gives the condition of both sections, and, with its indorsements, explains the present status of their improvement.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., October 31, 1891.

GENERAL: The improvement of the Staunton River, Virginia, was placed in my hands on the 14th of November, 1890. About that time an appropriation of $8,000 became available for use on this work, this amount having been appropriated by the act of Congress of 19th September, 1890. High water from that time onward prevented any work, or even examination of past work up to the present month.

In my annual report for the fiscal year ending June 30, 1891, I stated that "the

shallow draft, rocky bottom, steep slope at ledges, variable stage of water, and the existence now of two railroads near the main shipping portions of the river basin, rendered quite doubtful the advantage and economy of further improvement of the navigation of this stream at the present time, and I recommend that no further appropriations be made until after special examination of the results of past work and the cost and prospective benefits of future work." I have now just returned from examinations of the entire length of the portion of the river under improvement, this examination having been made by myself in person in a small skiff, at a stage of about 1 foot only above dead low water, this being the lowest stage of the present year and a stage well allowing a careful examination of the present status of the navigation facilities of this river. As a result of this examination I have now to recommend that the further improvement of this stream be stopped, that the funds now in hand be returned to the Treasury, and that no further funds be made available for this purpose at present.

The reasons for this recommendation will be evident from the following brief statements. The present improvement of this river extends over two sections—an upper one from Pig River down to Staunton River Station on the Virginia Mid-Midland Railroad, and a lower section from Brook Neal down to Randolph Station, on the Richmond and Danville Railroad. (Maps of these sections are shown on pages 836 of the Annual Report of the Chief of Engineers for 1888 and 786 of the Report for 1880, and the history of their original condition and of past operations thereon is briefly stated in my last annual report on this river, now printing.)

The upper section of the river, by its shallow draft, rocky bottom, and steep slope, is impracticable for freight steamboats unless dammed and locked every few miles through its entire length, but it may be used by the pole boats or bateaux for which the present approved improvement was planned. The $7,000 already spent on this section of the river has opened a fairly good navigation for such pole boats all the way up to Pig River, at least good enough to be used advantageously by such boats if water transportation were in demand. When this improvement was started there were mines near Pig River and at Seesville (16 miles below) which were seeking water transportion for their output.

To-day the neighboring railroad has extended a branch up to the mines near Pig River, and the water transportation is no longer in demand for the Pig River output, nor for any other freights on the 16 miles down to Seesville. At Seesville, however, two mines have been for some time in operation and two more are opening, and their product (about $8,000 per year at present, perhaps $16,000 by next year) goes down the river by pole boats 7 miles to the Staunton River Station on the Virginia Midland Railroad. The pole-boat channel of these 7 miles is in fairly good condition and the two pole boats now there can easily make a round trip each day and carry all the freight now offered to them. While the channel might be made a little better in one or two places, still the boats have not been prevented from running even at low water during the past two years. As there is no general commerce at all on this upper section of river from Pig River to the Virginia Midland Railroad, as all work of improvement by the United States is for the benefit merely of one or two corporations, and as the channelway is already equal to the commerce of the next several years, I am of the opinion that it is no longer advantageous and economical to the United States to spend any more money on this upper section of the river and that it is therefore not worthy of further improvement at present.

The lower section of the river from Brook Neal down to Randolph Station, on the Richmond and Danville Railroad, by its shallow draft, rocky bottom, and occasional rock ledges, is not practicable for navigation by freight steamboats of any great size, unless it were dammed and locked at three or four places, at an expense far beyond the present demands of its commerce; but its gentle slope allows of its being utilized for navigation by small stern-wheel freight steamboats, say 50 feet long, 10 feet wide, and of 2 feet draft or 25 tons burden. The $37,000 already spent upon this section of the river has opened a fairly good navigation for such steamers all the way from Brook Neal to Randolph, at least good enough to be used advantageously by such steamers if water transportation were in good demand. When this improvement was started there were large valuable plantations all along the river and no way of sending their goods to the nearest railroad except by the river or by a very long haul overland. To-day a new railroad, the Lynchburg and Durham, crosses the river 2 miles below Brook Neal and runs within about a mile of the river for 4 miles farther downstream to Clarkton Station. This renders unnecessary any further improvement of the river above Clarkton. The 25 miles from Clarkton down to Randolph are therefore the only portion of this lower section whose navigation is worth considering at present. While the channel might be made a little better than at present, still the present steamer has been in use for about a year, and has not been prevented from running a round trip over the river any day, even at low water, when freight was offered to it. But the freights have not kept this single 25-ton boat busy more than half the time. Moreover, this section of the river is now in splendid condition for pole-boat use, and this steamer and a few pole boats can easily

carry all the commerce in sight and all the probable prospective commerce for many years to come. The total freights carried by the present boat during 1890 (a bad year on account of freshets) was only about 800 tons ($31,000), and that of the present year (a good crop year) is estimated at less than twice that amount. As further work on this river will be very expensive in proportion to the results to be gained thereby, and as the present channelway is already equal to the commerce of the next several years, I am of the opinion that it is no longer advantageous and economical to the United States to spend any more money on this lower section of the river, and that it is therefore not worthy of further improvement at present.

As these two sections of the Staunton River, Virginia, are the only sections of the river for which appropriations have been made by Congress, and as neither of them is, in my opinion, worthy of further improvement at present, I have to recommend as above that the further improvement of this river be stopped; that the plant and other property belonging thereto be sold; that the proceeds, together with the other available funds, be covered into the Treasury, and that no further funds be made available for this work at present.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 6, 1891.

Respectfully referred to Col. W. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division, for remark.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
9 PLEASANT STREET,
Baltimore, Md., November 9, 1891.

Respectfully returned to the Chief of Engineers, U. S. A. I went over the Staunton River with Mr. Abert shortly before his relief from duty as United States agent. In an indorsement on a communication of June 2, 1890, from Mr. Abert to the Chief of Engineers, I stated "This is one of the rivers of which, in my opinion, the improvement should not be continued by the United States."

I am still of the same opinion and therefore agree fully with Capt. Bixby in his recommendations, except that it may be expedient to refrain from a sale of the plant until Congress has had the opportunity to further consider the subject of the improvement.

W. P. CRAIGHILL,
Colonel, Corps of Engineers.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 10, 1891.

Respectfully returned to Capt. Bixby.
The views of the Division Engineer are approved.
To be noted and returned to this office.
By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

The disposition to be made of the plant, valued at $650, awaits the action of Congress on the foregoing recommendations.

Amount expended separately on lower section	$37,314.53
Amount expended separately on upper section	7,000.00
Amount expended since the consolidation of the accounts on both sections	385.47
Total expended upon the improvement to June 30, 1892	44,700.00

Money statement.

July 1, 1891, balance unexpended	$7,981.74
June 30, 1892, amount expended during fiscal year	147.00
July 1, 1892, balance unexpended	7,834.74
July 1, 1892, outstanding liabilities	34.74
July 1, 1892, balance available	7,800.00
Amount (estimated) required for completion of existing project	50,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	(*)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Staunton River, Virginia.

APPROPRIATED.

Date.	Amount.	Aggregate.
March 3, 1879	$5,000	$5,000
June 4, 1880	7,500	12,500
March 3, 1881	5,000	17,500
August 2, 1882	7,000	24,500
July 5, 1884	5,000	29,500
August 5, 1886	10,000	39,500
August 11, 1888	5,000	44,500
September 19, 1890	8,000	52,500

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1880	$3,897.62	$3,897.62
1881	4,636.75	8,534.37
1882	8,727.66	17,262.03
1883	1,998.14	19,260.17
1884	4,648.47	23,908.64
1885	2,949.94	26,858.58
1886	1,830.59	28,689.17
1887	3,924.27	32,613.44
1888	6,071.60	38,685.04
1889	3,349.14	42,034.18
1890	2,280.35	44,314.53
1891	238.47	44,553.00

L 2.

IMPROVEMENT OF ROANOKE RIVER, NORTH CAROLINA.

The Roanoke is formed by the Staunton and Dan, which rise in the Blue Ridge.

From their confluence to its mouth at Albemarle Sound its length is 198 miles.

Formed in the easterly part of the middle undulating belt of North Carolina, its course, from the head of navigation at Weldon, lies southeasterly across the low and level expanse of pine forests, intersected

* A recommendation that work be discontinued under project was approved by the Chief of Engineers November 10, 1891.

by cypress morasses, that embraces about 3,000,000 acres of the easterly part of the State.

It is nontidal, Albemarle Sound being a body of fresh water with no lunar tides. The surface of the sound, however, at the river mouth is raised and lowered respectively by protracted northeasterly and southwesterly winds which cause extreme fluctuations of about 2 feet.

Freshets in the river are frequent and sudden, causing an extreme recorded rise of 50 feet at Weldon, 26 feet at Norfleets Ferry, and about 6 feet at Jamesville.

From Weldon down 111 miles to Jamesville it overflows its banks and submerges large areas of bottom lands, which, before the war, from Halifax down 53 miles to Hamilton were protected by levees now much out of repair.

From its mouth 18 miles to Jamesville its width is from one-third to one-half mile, its depth at low water not less than 27 feet, its bed muddy, and its current sluggish. From Jamesville up 49 miles to Indian Highland Bar its width is 300 to 350 feet, its depth not less than 15 feet, its bed in the channel of coarse sand, and its current at low water $1\frac{1}{2}$ to 2 miles per hour. From Indian Highland Bar up 51 miles to Halifax its width is from 350 to 450 feet, its bed in the channel of coarse sand with numerous sand bars and three of coarse gravel and bowlders, namely, Indian Highland Bar and Big and Little Rocky Bars immediately above and below Norfleets Ferry, its depth at low water being about 10 feet in the pools and $2\frac{1}{2}$ feet on the bars, and its current at low water from 1 to $1\frac{1}{2}$ miles per hour.

At Halifax the first bar of rock is met, extending from the right and concave bank about halfway across the river, thence 9 miles to the old railroad pier, 1 mile below Weldon, the bed of the channel is of sand, its width 400 to 500 feet, its depth at low water 3 to 5 feet, and its current about 1 mile per hour. From the bridge piers 1 mile to the rapids and head of navigation at Weldon its bed is of rock and its depth at low water $2\frac{1}{2}$ to 3 feet.

Its banks, about 60 feet in height at Weldon, descend to about 10 feet at Jamesville, whence to its mouth the river flows through a cypress swamp. The banks, not only concave but straight, for stretches of several hundred yards often cave badly after freshets, precipitating standing trees into the river and entailing perpetual repetition of clearing the river of snags.

When the United States commenced the improvement of the river in 1872 its navigation by vessels of 10 feet draft, as great as can be carried through the Albemarle Sound, was embarrassed by the wreck of the gunboat *Southfield*, sunk by the ram *Albemarle*, 6 miles above the mouth, by three rows of piles extending across the river at Tallow Island, 3 miles higher, and by a row of schooners filled with stones and scuttled at Broad Creek, 13 miles above the mouth. These, with like obstructions at other points, which did not in 1872 interfere with navigation, were all placed in the channel during the war.

Below Indian Highland Bar the channel was also somewhat obstructed by leaning trees and by snags for vessels drawing 10 feet, below which depth masses of snags, logs, and stumps were lodged in its pools. From Indian Highland Bar 62 miles up to Weldon the least channel depth on the bars was about 5 feet during eight months annually, but was reduced to 2 feet during the annual season of extreme low water, and the whole 62 miles of the river were badly obstructed by snags, logs, and stumps and leaning and overhanging trees.

With appropriations made annually from 1871 to 1874, both inclusive,

and in 1882, 1884, 1886, 1888, and 1890, aggregating $138,000, the improvement of the river has been in progress under the project of 1872 to secure at all seasons of the year an unobstructed channel with a least width of 50 feet from the mouth, 129 miles, to Weldon, with a depth of at least 10 feet 67 miles up to Indian Highland Bar, and of at least 5 feet 62 miles farther to Weldon, by removing the war obstructions, snags, fallen and overhanging trees, sand bars and ledges, by dredging, the construction of training dikes, and blasting, at an estimated cost of $269,000.

The war obstructions were long ago removed, and the depth on Indian Highland Bar, originally not more than 5 feet, was increased by the construction of training dikes to 7 feet at low water. Then a channel was imperfectly cleared of snags, logs, and stumps wherever they were found from Weldon, 111 miles, to Jamesville, to permit vessels to get through, after which the cleared channel was widened to 100 feet and more thoroughly cleared to the depth of 10 feet up to Hamilton, 7 feet thence to Big Rocky Bar, and to the natural depth thence to Weldon.

Channels to the depth of 5 feet and width of 115 feet and length of about 700 feet, and to the width of 184 and length of about 440 feet were dredged respectively through Big Rocky Bar and Little Rocky Bar, upon which the least depth of water was about 2½ feet, and some blasting was done to remove the higher points of rock from the channels at Halifax and Weldon.

By indorsement of May 14, 1890, from the office of the Chief of Engineers, $6,000 were allotted for application to dredging a cut-off 1,100 feet in length at Shad Island Bend, 29½ miles above the mouth of the river, of which about $1,000 were applied, in July, 1890, to clearing the site of trees and stumps and in dredging a cut 23 feet wide, 7 feet deep, to about the level of low water and 150 feet long when the work was suspended. Its resumption awaits the conveyance to the United States of title to the site.

The cut will be dredged with the remaining $5,000 of the $6,000 allotted only to a partial cross section of the channel desired, leaving it to be enlarged by scour.

The bend is a double one, very sharp, and very seriously embarrasses navigation by the larger steamers on the river.

During the fiscal year which ended June 30, 1892, from Edwards Ferry down 41 miles to Hamilton, the river has been entirely cleared of snags to its full width, and to the depth of 7 feet 24 miles down to Palmyra, and of 9 feet the remaining 17 miles to Hamilton, and the banks trimmed of all overhanging trees and limbs throughout the 41 miles.

Snagging and bank trimming were discontinued March 30, 1892, to reserve about $5,000 for application to dredging the cut-off at Shad Island Bend as soon as title to the site can be secured.

The months of April, May, and June were devoted to thoroughly repairing the plant at Palmyra.

The magnitude of the obstructions to be removed from channel and banks and their location and extent along the river are not susceptible of even approximately accurate definition; the time when work can be done and the period which it will consume are rendered very uncertain by the frequent and sudden freshets, and work is further hampered by the unhealthiness of the low-water season when it can best be done. To insure himself against loss under such conditions a contractor must provide a wide margin in price, while the necessity for efficient inspection would duplicate the cost of superintendence, and the obstructions

could not be by contract so readily removed in the order required by the interests of navigation.

All work during the year has, therefore, been done by hired labor with United States plant.

The details of the work during the fiscal year, plant used, and obstructions removed from the river, are fully given in the appended report of Mr. Charles Schuster, who has been throughout the year and for the five years preceding in immediate charge of the work, which he has very faithfully and efficiently conducted.

At the date of this report the condition of the river is as follows:

For 25 of the 44 miles between Jamesville and Hamilton navigation is much obstructed by overhanging trees, and boats are annoyed in going downstream by snags outside of the channel 100 feet wide that was cleared throughout the 25 miles. Elsewhere from Weldon to the river mouth it is unobstructed by leaning trees from its banks, and is cleared of snags, logs, and stumps to a depth not exceeding 5 feet at extreme low water from Weldon to Indian Highland Bar, and to the depth of 10 feet at extreme low water thence to its mouth.

At Spring Gut Bar, 46 miles below Weldon, the depth at extreme low water is only 2½ feet for a distance of 150 feet, and at Looking Glass Bar, 26 miles below Weldon, the 5-foot channel at extreme low water is at three points only 70, 40, and 30 feet wide respectively, elsewhere from Indian Highland Bar 25 miles up to Halifax there is a cleared channel over all bars of good navigable width and not less than 5 feet deep at extreme low water as prescribed in the project.

But in the 11 miles from Halifax up to Weldon the 5-foot channel is interrupted, first, by a bar at Halifax 2,450 feet across, 1,800 feet of which are of sand upon which the depth is but about 3 feet, and 650 feet of which are of rock upon which the depth is but about 3.7 feet at extreme low water; second, at the old railroad pier, 1¼ miles below Weldon, by a sand bar 800 feet across, upon which the depth at extreme low water is about 2 feet; and third, by a bar of rock extending from the old Weldon Ferry 2,850 feet to old Weldon Landing, upon which the depth at extreme low water is only about 1 foot. Elsewhere between Halifax and Weldon the channel is not less than 5 feet deep at extreme low water.

The banks of these 11 miles are swampy and not settled, and the traffic on that part of the river, with railroad communication between Weldon and Halifax, would be so small, and the cost of attaining 5 feet depth prescribed in the contract would be so great by cutting through the bars of sand and rock, the continuance of the improvement between Halifax and Weldon is of doubtful expediency and will be made the subject of a special report.

Omitting these upper 11 miles, the cost of completing the project of 1872 throughout the rest of the river is estimated at $20,000, as follows:

For snagging 25 miles between Jamesville and Hamilton	$6,000
For bank trimming over same distance	7,000
For improving channel on Looking Glass Bar by construction of three jetties of mattress and stone	2,388
For improving channel at Spring Gut Bar by building one jetty of mattress and stone	660
For engineering, superintendence, and contingent expenses	3,952
Total	20,000

This sum can all be advantageously applied in the ensuing fiscal year.

From the appended table of amounts expended for the improvement

of the Roanoke River, and number and net tonnage of steam vessels navigating it above Plymouth from July 1, 1887, to June 30, 1892, it will be seen that the number of vessels increased from 9 in 1887, having a total net tonnage of 1,717.42, to 15 in 1889, having a total net tonnage of 2,120.16; but that they have since annually diminished to 5 steamers in 1892, having a total net tonnage of 713.96, a net decrease since 1887 of 44 per cent in the number of vessels and of 58 per cent in net tonnage during the six years in which upwards of $81,000 have been spent in clearing that river of snags, its banks of leaning trees, and in deepening its channel.

About 50 to 60 schooners of 25 to 50 tons each annually ascend the river 7 miles to Plymouth to discharge corn, fertilizers, and lime principally, and receive shingles and lumber; but except a few small fishing boats which go 11 miles higher to Jamesville, sailing vessels never go above Plymouth, and the part of the river which absorbs all the money applied to its improvement is navigated only by the steamers whose number and tonnage are given in the accompanying tables.

Of the six principal landings on the river, above overflow, at Halifax, Edwards Ferry, Palmyra, Hamilton, Jamesville, and Plymouth, the last five are the principal shipping points for cotton, only the last four of which have warehouses to receive it. Minor shipments from other points along the river are very much restricted because cotton as soon as placed upon the banks is liable to be swept away or damaged by the frequent and sudden freshets, and the arrival of steamers can not be relied upon within 24 or 48 hours, owing to the variable currents and vicissitudes due to the freshets. Fully half of the cotton grown in the river valley is shipped by railroad running from Weldon to Plymouth and touching it at Halifax, Williamston, and Jamesville, with three very direct railway lines, each about 80 miles in length, from the river to Norfolk. On account of this competition the freight on cotton by the quick and sure rail routes from the river valley to Norfolk is only 15 cents more per bale than by the slower water route.

The shipment of the crop of cotton usually commences during the latter part of the period of most extreme and protracted low water, which occurs about September and October, from which date until January the water gradually rises, and the shipment of cotton by river is heaviest.

The next and only other period of important and regular traffic upon the river is the shipment of fertilizers upstream in March when the water is high. Throughout the other months of the year shipments by water are very light and irregular.

The cost of removing the increase of leaning trees, snags, logs, and stumps will be about $3,000 to $5,000 annually.

The river is in the collection district of Edenton, N. C.

Money statement.

July 1, 1891, balance unexpended	$19,983.99
June 30, 1892, amount expended during fiscal year	12,845.57
July 1, 1892, balance unexpended	7,138.42
July 1, 1892, outstanding liabilities	259.07
July 1, 1892, balance available	6,879.35
Amount appropriated by act approved July 13, 1892	50,000.00
Amount available for fiscal year ending June 30, 1893	56,879.35

Amount (estimated) required for completion of existing project	*$81,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1884	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. CHARLES SCHUSTER, OVERSEER.

SCOTLAND NECK, N. C., *June 30, 1892.*

MAJOR: I have the honor to make the following report of operations upon the improvement of Roanoke River, North Carolina, during the fiscal year ending June 30, 1892:

The work done during the fiscal year consisted chiefly of snagging and bank trimming.

The channel has been cleared to its full natural width of all snags, stumps, logs, and trees for a distance of 41 miles, viz, from Edwards Ferry, 103 miles above the river month, to Hamilton, 67 miles above the river month. The cleared channel depth at extreme low water was 5 feet from Edwards Ferry to Big Rocky Bar, 9 miles; 7 feet from Big Rocky Bar to Palmyra, 15 miles; and 9 feet from Palmyra to Hamilton, 17 miles.

The obstructions removed from the channel were: Large snags, 5,530; stumps, 606; cords small snags, 199.

In addition to the above work a large number of snags, probably 1,500 or 2,000, were chopped into short lengths during very low water, and were allowed to sink to the bottom. This method has proved a very good one where trees had fallen into the river from the banks but their roots were still embedded in the bank, and where the water was of sufficient depth to allow of the chopped material being dropped where cut without obstructing the channel. Care was taken to begin at the top of each tree and cut towards the roots, and to cut the separate pieces so that there would not be any forks or projecting ends of limbs.

The cost of removing a fallen tree in this manner is only about one-fourth of hoisting and putting the same tree on the bank.

Owing to the fact that the channel has been cleared to its full natural width, which is from 250 to 300 feet, and the extraordinary large dimensions of the removed obstructions, the progress of the work has been slow.

Bank trimming has been done where necessary from Edwards Ferry to Hamilton, distance 41 miles. Seventy-eight trees were cut and hauled back and 1 cord of brush cut.

Operations in field were suspended March 30, 1892, for lack of funds, and the plant towed to Palmyra for repairs.

Detailed surveys were made of Looking Glass, Leggetts, Spring Gut, and Hickory Neck bars with reference to the location of dikes or other means of contraction so as to secure a channel depth of 5 feet on such of these bars as need it. Field maps showing all details of shoals and channels and character of bottom were submitted after completion of surveys.

Gauge observations were taken daily during the entire fiscal year at the stations at Weldon, Norfleets Ferry, Hamilton, Williamston, Jamesville, and Plymouth.

A new scow, 40 feet long by 16 feet wide and 3 feet 9 inches deep, was built for the transportation of fuel, etc., at a total cost of $180.67; also a new quarter boat to accommodate 30 men and of the same dimensions of hull was built to replace an old one, since condemned. The cost of constructing this quarter boat was $342.01.

The hoister *Roanoke* was thoroughly overhauled and repaired. The position of the engine and boiler was changed so as to increase the capacity for carrying fuel and to bring the smokestack amidships. The shaft for side wheels was raised 3 inches, and a new house and derrick were erected.

The plant is now in good condition.

I regret to have to report a decrease in the number of steamers running on this river. This decrease is doubtless owing to the good shipping facilities by rail in this vicinity, and owing to the competition between the railroad companies their rates are but little higher than river rates, besides delivery of goods and products being quicker and surer.

Very respectfully, your obedient servant,

CHAS. SCHUSTER,
Overseer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

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*Eighty-one thousand dollars is the difference between original estimates and the appropriations thus far made. Twenty thousand dollars will complete the project up to Halifax; its completion thence 11 miles to Weldon will cost materially less than the remaining $111,000, but is of very doubtful expedience, and will be made the subject of a special report after a further examination.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$574,339		$574,339	4,786
Tobacco	15	$4,190	4,205	42
Rice	3,529	1,325	4,854	121
Grains and forage	282,835	37,145	319,980	15,998
Vegetables and truck	38,941		38,941	12,009
Live stock and products	10,539	17,755	28,294	282
Fish, oysters, etc	34,723	405	35,128	3,512
Naval stores	1,898		1,898	946
Lumber and products	3,262,899		3,262,899	326,289
Fertilizers	32,000	12,400	44,400	1,110
Machinery	36,300	900	37,200	930
General merchandise	412,640	573,518	986,158	9,860
Sundries	29,566	960	30,526	305
Total	4,720,219	648,598	5,368,817	376,181

Gain over last year: $1,175,687; tons, 193,481.

The above statistics are based mainly upon reports of Overseer Charles Schuster, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Roanoke River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
March 3, 1871	$20,000	$20,000
June 10, 1872	10,000	30,000
March 3, 1873	10,000	40,000
June 23, 1874	5,000	45,000
August 2, 1882	5,000	50,000
July 5, 1884	3,000	53,000
August 5, 1886	20,000	73,000
August 11, 1888	40,000	113,000
September 19, 1890	25,000	138,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1871	$220.75	$220.75
1872	8,782.18	9,002.93
1873	6,923.66	15,926.59
1874	13,739.02	29,665.61
1875	4,748.27	34,413.88
1876	5,303.49	39,717.37
1877	5,100.65	44,818.02
1878	181.98	45,000.00
1883	1,274.81	46,274.81
1884	2,748.00	49,022.81
1885	676.95	49,699.76
1886		49,699.76
1887	9,278.58	58,978.34
1888	11,457.38	70,435.72
1889	11,021.09	81,456.81
1890	20,578.01	102,034.82
1891	17,005.55	119,040.37

Roanoke River, North Carolina—Continued.

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1871	150,000	$3,500,000
1885		14,452,500
1887		5,286,000
1888		2,839,000
1889		14,355,500
1890		4,986,000
1891	182,700	4,193,130

Statement of amount expended upon improvement of Roanoke River, North Carolina, and number and total net tonnage of vessels navigating it annually, from July 1, 1887, to June 30, 1892.

Year ending—	Amount expended.		Steamers.	
	Each year.	Total.	Number.	Registered net tonnage.
1887	$9,278.88	$9,278.88	9	1,717.42
1888	11,457.38	20,736.26		
1889	11,021.09	31,757.35	15	2,120.16
1890	20,578.01	52,335.36	13	1,920.16
1891	17,005.55	69,340.91	8	1,577.41
1892			5	713.96

List of steamers navigating the Roanoke River, North Carolina.

FISCAL YEAR ENDED JUNE 30, 1887.

Names of steamers.	Net tonnage.	From—	To—	Number of trips.
Conoho	297.57	Hamilton	Baltimore	Weekly.
Meteor	336.80	......do	......do	Do.
Hamilton	300.31	......do	......do	Do.
Ranger	69.24	......do	Edenton	Do.
Plymouth	210.15	Williamston	......do	Daily.
Lucy	76.36	Edwards Ferry	Norfolk	Weekly.
Currituck	100.00	......do	......do	Do.
Bertie	35.47	Plymouth	Windsor	Daily.
Susie Hitch	291.52	Hamilton	Baltimore	Weekly.
Total	1,717.42			

FISCAL YEAR ENDED JUNE 30, 1889.

Conoho	297.57	Hamilton	Baltimore	Weekly.
Meteor	336.80	......do	...do	Do.
Hamilton	300.31	......do	...do	Do.
Ranger	69.24	......do	Edenton	Do.
Plymouth	210.15	Williamston	...do	Daily.
Martha E. Dickerman	162.62	......do	...do	Do.
Lucy	76.36	Edwards Ferry	Norfolk	Weekly.
Currituck	100.00+	Plymouth	...do	Do.
A. McCall	100.00+	Jamesville	Montrose	Daily.
Bertie	35.47	Plymouth	Windsor	Do.
Susie Hitch	291.52	Hamilton	Baltimore	Weekly.
Comet	73.80	......do	Bull Hill Landing	Biweekly.
George H. Reeves*	19.85	Plymouth	Norfolk	Weekly.
Manistee*	17.15	......do	...do	Do.
Belle of Virginia*	29.23	......do	...do	Do.
Total	2,120.16+			

*Tugboats.

List of steamers navigating the Roanoke River, North Carolina—Continued.

FISCAL YEAR ENDED JUNE 30, 1890.

Names of steamers.	Net tonnage.	From—	To—	Number of trips.
Conoho	297.57	Hamilton	Baltimore	Weekly.
Meteor	336.80	...do	...do	Do.
Hamilton	300.31	...do	...do	Do.
Ranger	69.24	...do	Edenton	Do.
Plymouth	210.15	Williamston	...do	Daily.
Martha E. Dickerman	162.62	...do	...do	Do.
Lucy	76.30	Edwards Ferry, N. C.	Norfolk	Weekly.
Comet	73.89	Bull Hill Landing	Hamilton	Biweekly.
Bertie	35.47	Plymouth, N. C	Windsor	Daily.
Susie Hitch	291.52	Hamilton	Baltimore	Weekly.
Geo. H. Reeves	19.85	Plymouth	Norfolk	Do.
Manistee	17.15	...do	...do	Do.
Belle of Virginia	29.23	...do	...do	Do.
Total	1,920.16			

FISCAL YEAR ENDED JUNE 30, 1891.

Names of steamers.	Net tonnage.	From—	To—	Number of trips.
Conoho	297.57	Hamilton	Baltimore	Weekly.
Meteor	336.80	...do	...do	Do.
Hamilton	300.31	...do	...do	Do.
Plymouth	210.15	Williamston	Edenton	Daily.
Lucy	76.36	Edwards Ferry	Norfolk	Weekly.
Bertie	35.47	Plymouth	Windsor	Daily.
Susie Hitch	291.52	Hamilton	Montrose	Weekly.
Belle of Virginia	29.23	Plymouth	Norfolk	Do.
Total	1,577.41			

FISCAL YEAR ENDED JUNE 30, 1892.

Names of steamers.	Net tonnage.	From—	To—	Number of trips.
Plymouth	210.15	Williamston	Edenton	Daily.
Lucy	76.36	Edwards Ferry	Norfolk	Weekly.
Susie Hitch	291.52	Hamilton	Montrose	Do.
Bertie	35.47	Plymouth	Windsor	Daily.
Harry	100.46	Edwards Ferry	Montrose	Weekly.
Total	713.96			

L 3.

IMPROVEMENT OF PASQUOTANK RIVER, NORTH CAROLINA.

The Pasquotank River, Dismal Swamp Canal, and Elizabeth River form an inland waterway from Albemarle Sound to Hampton Roads in Chesapeake Bay.

The canal first joined the Moccasin Track, a tributary to the Pasquotank, about 1,100 feet above their confluence, but the Moccasin Track and the river for about 5 miles below it were so choked with snags, logs, and stumps to avoid them an extension of the canal, known as Turners Cut, was dug parallel with the general course of the river, joining it just below the obstructions, whence to Albemarle Sound the river had an almost unobstructed channel 9 feet deep at Turners Cut, 13 feet deep at the sound, and nowhere less than 7 feet deep between them.

Turners Cut, commenced in 1857, was barely finished when the war began in 1861, and has shoaled by the caving of its sandy banks. The

present project, adopted in 1889, for the improvement of the river is, First, by clearing the snags, logs, and stumps from the 5 miles of obstructed channel below the Moccasin Track, and from the Moccasin Track up to the canal, and by trimming their banks to make them "permanently available for use by all vessels and steamers that can now pass through the Dismal Swamp Canal;" and secondly, to extend like improvement 4 miles above the Moccasin Track to Lebanon Bridge to permit flatboats to be poled up to that point.

The improvement commenced with $3,000 appropriated by the act of September 19, 1890, by the application of which in the fiscal year 1890-'91 the Moccasin Track was entirely cleared below the canal, and likewise a channel 60 feet wide in the river for 2½ miles below their confluence, whence the same width was fairly cleared 2½ miles farther and through the obstructions, permitting boats to pass of any draft that can navigate the canal.

Work was then suspended and has continued suspended during the year 1891-'92.

Notwithstanding the advanced state of the improvement of the Moccasin Track and river branch of the route, canal boats still use Turner's Cut. Nor is it probable, were the Moccasin Track and river route entirely cleared, that boats would use it instead of the cut, because the canal has shoaled as well as the cut itself, so that vessels can now draw through the cut as much water as through the canal, which is reported by the superintendent of the canal to be 4½ feet *when the canal is full.*

Moreover, there is a tow-path along Turners Cut permitting boats to be towed through it by mules, while they must be poled by hand a distance about 1½ miles longer through the Moccasin Track and river.

It is reported that about 1,250 tons of freight pass from the Pasquotank River into the canal and that about 750 tons pass from the canal into the river annually; also that logs making about 1,000,000 feet of lumber are annually floated down the river to the mills at Elizabeth City from the Upper Pasquotank, its tributaries, and Turners Cut.

No work has been done above the Moccasin Track. That part of the river is narrow and crooked, badly obstructed, in the Dismal Swamp, and its present commerce is insignificant and carried on by skiffs.

From a personal inspection of the river up to the Moccasin Track by the District Engineer in January, 1892, and from information received from the reliable superintendent who was in immediate charge of the foregoing improvement for three and a half months in 1891, it is believed that the river above the Moccasin Track is not worthy of improvement.

In view of all the foregoing facts as regards the river, whether independently or as a part of the canal route, it is therefore recommended that the improvement of the Pasquotank River above the mouth of Turners Cut be discontinued.

The two counties, Pasquotank and Camden, in which the improvement is located, have a total area of 520 square miles.

Including Elizabeth City, their population, by the United States census, was, in 1860, 14,283; in 1880, 16,643; and in 1890, 16,415.

In 1879, 1,941 bales of cotton were produced upon 6,674 acres, and in 1889, 2,390 bales upon 8,454 acres.

The river is in the collection district of Elizabeth City, N. C.

Money statement.

July 1, 1891, balance unexpended	$722.30
June 30, 1892, amount expended during fiscal year	132.45
July 1, 1892, balance unexpended	589.85
July 1, 1892, outstanding liabilities	6.00
July 1, 1892, balance available	583.85
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,583.85
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	*3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Pasquotank River, North Carolina.

Appropriated—	
March 2, 1829	$80.00
September 19, 1890	3,000.00
Expended, fiscal year ending—	
June 30, 1829	†47.25
June 30, 1891	2,340.28
Freight transported during fiscal year ending June 30, 1891 (150,000 tons)	900,000.00

L 4.

IMPROVEMENT OF MACKEYS CREEK, NORTH CAROLINA.

Mackeys Creek flows into Albemarle Sound from its south shore and about 6 miles from the mouth of the Roanoke River.

From its mouth, one-half mile up to Mackey Ferry, the creek is not less than 150 feet wide and 12 feet deep. The bar at its mouth is about 2,100 feet across and has a narrow and somewhat circuitous channel, with a least depth of about 7 feet, there being no tide in the sound, except from winds which produce oscillations of about 2 feet.

Mackey Ferry is the terminus of a railroad running 39 miles south into the lumber region about Pungo River. Cars carrying cypress shingles, passengers, and mail are towed on flatboats from the ferry about 9 miles across the sound to Edenton, whence they continue by railroad 70 miles farther to Norfolk. The flatboats make from one to two round trips daily. To facilitate the towing of them across the bar the present project was adopted in 1889 to dredge a channel through it 9 feet deep, 100 feet wide, and 2,100 feet long, at an estimated cost of $15,000, which sum was appropriated therefor by the act of September 19, 1890.

Contract was entered into with the Alabama Dredging and Jetty Company, Mobile, Ala., April 7, and approved April 10, for dredging, at 26 cents per cubic yard, measured in scows, to be commenced by October 17, 1891, and completed by April 23, 1892. March 4 the contract was extended 90 days to July 22, 1892.

Dredging was commenced February 13, 1892, and to the date of this

*For removing snags which somewhat obstruct channel below lower mouth of Turners Cut.

† Balance of $32.75 turned over to surplus fund.

[illegible] of material, with many cypress [illegible] removed, making a straight cut [illegible] of 1,524 feet, and 120 feet [illegible] 60 feet to facilitate towing the [illegible] ly or westerly winds blow [illegible] wreck of a schooner laden with shingles [illegible] across the sound in 1820. [illegible] States hoister *Roanoke*, from the [illegible] Mackey Ferry are made into rafts in the [illegible]. Logs are frequently dropped from these [illegible] the channel, to prevent which the nec- [illegible] inspected by Mr. S. F. Burbank, [illegible] of Edenton, N. C.

Money statement.

[illegible]		$14,650.52
[illegible] year		7,658.46
		6,992.06
[illegible] contracts	$4,053.09	
[illegible]	2,246.66	
		6,299.75
[illegible]		692.31

COMMERCIAL STATISTICS.

[illegible] ending December 31, 1891, is estimated as follows:

[illegible]	Exports.	Imports.	Totals.	Tonnage.
[illegible]	$161,993		$161,993	1,156
[illegible]	918		918	31
[illegible]	7,788		7,788	402
[illegible]	67,045		67,045	1,437
[illegible]	6,150		6,150	37
[illegible]	18,067		18,067	131
[illegible]	200,917		200,917	25,392
[illegible]	2,850		2,850	600
[illegible]	5,000		5,000	200
[illegible]	23,485	$229,200	246,685	4,511
[illegible]	1,853		1,853	25
[illegible]	496,076	223,200	719,276	32,922

[illegible] 1,75[illegible], tons, 1,510.

[illegible] during year. None.

[illegible] based mainly upon reports of Inspector S. F. Burbank, [illegible] and conversation with steamboat captains and [illegible] and prominent shippers and merchants.

Mackeys Creek, North Carolina.

[illegible] 1890	$15,000.00
[illegible] June 30, 1891	359.48
[illegible] during fiscal year ending June 30, 1891 (32,410 tons).	607,100.00

L 5.

IMPROVEMENT OF OCRACOKE INLET, NORTH CAROLINA.

Ocracoke Inlet from the Atlantic Ocean to Pamlico Sound through the narrow sand bank separating them, is WSW. about 25½ miles and 15 miles respectively from Cape Hatteras and Hatteras Inlet, and about 34 miles NE. from Cape Lookout.

Hatteras and Ocracoke inlets are the two most important openings through the sand bank with navigable channels from the ocean to the sound. The channels on their ocean bars are changeable.

Regarding Hatteras Inlet, it is stated in the Atlantic Coast Pilot:

> In January, 1884, there was but 13 to 14 feet on the bar at low water. At times but 10 feet can be carried over it, but at other times as much as 15 feet at low water will be found. * * * The communication of the inlet with the sound is through shallow swash channels across the inner bar or bulkhead.

Through their inner channels, which are changeable, although less so than on the outer bar, it is stated in the Coast Pilot that 7 feet may be ordinarily taken at high water, and that the range of tides is 1.9 feet.

At Ocracoke Inlet, by the Atlantic Coast Pilot, "in January, 1884, there was 15 feet on the bar at high water."

According to the Coast Pilot, in 1884, from within the bar there could be taken at high water 6½ feet through the northerly of the two channels over the bulkhead into the sound, and 4½ feet through the southerly branch or slough.

By a survey made in 1891 for the preparation of the project for the improvement, the depth in the channel on the outer bar was not less than 14 feet at mean low water, and through the two channels thence into Pamlico Sound "from 4 to 6 feet." The range of tides on the bar is 3 feet; at the anchorage within it is 1½ feet, and at the end of the southerly channel near the sound 1.2 feet.

In the Annual Report of the Chief of Engineers, 1889, page 1122, it is stated:

> Under the influence of storms the ocean bar of Hatteras Inlet is reported as being sometimes better and sometimes worse than Ocracoke; but the advantage is reported as returning soon to Ocracoke both as to depth and permanency of direction of the bar channel.

It appears from House Ex. Doc. No. 64, Forty-eighth Congress, first session, page 43, that in 1828 vessels drawing 9 feet could pass in from the ocean at low water, but that the channel inside was not practicable for vessels drawing more than 5 feet, and that between 1826 and 1837 the sum of $133,732.40 was expended "in deepening one of the channels from Pamlico Sound to the Inlet, during which time an increase of about 3½ feet of water was obtained with at first great promise of permanence." The following is further quoted from that document regarding the improvement at Ocracoke Inlet at that time:

> In 1836, to prevent the formation of a shoal that had begun to form at the outlet of the dredged channel, resort was had to a jetty for the concentration of the current. This, when nearly completed, was materially injured by a violent storm in August, 1837.
>
> The continued shoaling of the dredged channel and the destruction of this jetty eventually led to the final abandonment of the work.
>
> Between the years 1830 and 1835 the benefit to commerce was a material increase in the number of vessels seeking this outlet from North Carolina ports to the sea.

A very large part of the water traffic from the Roanoke, Pamlico and Tar, and Neuse rivers, and Albemarle and Pamlico sounds, into which

they flow, now passes in boats not exceeding about 7 or 8 feet draft through the Albemarle and Chesapeake Canal to Norfolk.

The object of the improvement of Ocracoke Inlet is to give vessels of 9 feet draft which can reach it from Albemarle Sound and the Lower Roanoke, and of greater draft which can reach it from the Lower Neuse and Pamlico rivers, direct access to the ocean, and also to enhance its value as a harbor of refuge for coasting vessels.

Pursuant to the act of August 11, 1888, an examination was made, and on March 13, 1889, a project was submitted by the officer then in charge for improving the southerly channel into the sound by dredging a cut 100 yards wide through the shoals at an estimated cost of $100,000 if 10 feet deep, of $190,000 if 13 feet deep, and of $280,000 if 15 feet deep; in addition to which the estimate embraced $320,000 for "such protecting work" as "may possibly prove necessary" to maintain the dredged channel, the aggregate estimated cost "of dredging and diking" being $600,000.

The act of September 19, 1890, appropriated $90,000 for the improvement. The inlet within the bar was surveyed by First Lieut. Mason M. Patrick, Corps of Engineers, in January to May, 1891. Contract with the Alabama Dredging and Jetty Company was entered into November 28 by the officer then in charge, and approved December 4, 1891, for dredging to the depth of 12 feet "to the extent of about $75,000 worth of work," to commence on or before May 7, 1892, and to be completed January 23, 1893. May 10, 1892, the contract was extended for work to commence June 6, 1892, and June 11, 1892, and it was again extended, the work to be commenced by August 3, 1892, and to be completed by April 7, 1893.

April 2, 1892, the district engineer was, upon the recommendation of the Division Engineer, ordered by the Chief of Engineers to submit a special report, "with estimates of the costs of obtaining and *maintaining* depths of 10, 12, 14, or 15 feet at low water, with his views as to the present and prospective requirements of the situation."

A large number of circulars has been issued to secure information, especially as regards the usefulness of the inlet as a harbor of refuge, for the preparation of this report, which will be submitted early in the ensuing fiscal year.

This inlet is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1891, balance unexpended		$88,274.29
June 30, 1892, amount expended during fiscal year		404.57
July 1, 1892, balance unexpended		87,869.72
July 1, 1892, outstanding liabilities	$95.56	
July 1, 1892, amount covered by uncompleted contracts	75,000.00	
		75,095.56
July 1, 1892, balance available		12,774.16
Amount appropriated by act approved July 13, 1892		15,000.00
Amount available for fiscal year ending June 30, 1893		27,774.16
Amount (estimated) required for completion of existing project		(*)
Amount that can be profitably expended in fiscal year ending June 30, 1894		(*)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

* No estimate and recommendation for further appropriations can be submitted until the further examination of the project and of the present and prospective requirements of navigation required by indorsement from office of Chief of Engineers April 2, 1892, has been made.

Abstract of proposals for dredging in Ocracoke Inlet, North Carolina, received in response to advertisement dated September 5, 1891, and opened at 12 o'clock m., October 20, 1891, by Capt. W. H. Bixby, Corps of Engineers.

No.	Name and address of bidder.	Price bid per cubic yard in scows.	Remarks. To commence within—	Remarks. Weekly progress.
		Cents.		*Cubic yards.*
1	P. Sanford Ross, Jersey City, N. J	34	90 days	7,200
2	American Dredging Co., Philadelphia, Pa	30	60 days	7,500
3	Chester T. Caler, Norfolk, Va	41	200 days	7,000 to 10,000
4	Moore & Wright, Portland, Me	31	6 months	8,000
5	Alabama Dredging and Jetty Co., Mobile, Ala	17	150 days	12,000

Recommended for award to No. 5, Alabama Dredging and Jetty Company.

Ocracoke Inlet, North Carolina.

Appropriated—	
March 20, 1826, to March 3, 1837	$133,750.00
September 19, 1890	90,000.00
Expended fiscal year ending—	
June 30, 1826, to 1837	*133,732.40
June 30, 1891	1,747.71
Freight transported during fiscal year ending June 30, 1891 (15,000 tons).	9,300.00

L 6.

IMPROVEMENT OF FISHING CREEK, NORTH CAROLINA.

Fishing Creek is a tributary to the Tar River, which it joins 56 miles above Washington, N. C., and 96 miles above the river mouth at Albemarle Sound.

From its mouth 38 miles up to Bellamys Mills its slope is gentle and its depth about 4 feet at ordinary stages, but it is so much obstructed by snags, logs, and leaning trees that it is unnavigable, and one has, in places, to pick his way over it even in a skiff.

It flows through a country in part cultivated, in part cleared but not cultivated, and in part forest, which contains a considerable quantity of valuable timber, gum, cypress, hickory, oak, and pine.

At Bellamys Mills the stream is crossed by a dam 160 feet long and 12 feet high, over which an average depth of 12 inches of water is said to be discharged throughout the entire year.

The project of 1889 is to clear the creek of snags, logs, and overhanging trees, from its mouth, 38 miles, to Bellamys Mills, at a cost roughly estimated at $25,000.

By the act of September 19, 1890, the sum of $10,000 was appropriated for beginning the improvement, with the proviso—

> That no part of this sum shall be expended until the bridges over that part of said river to be improved have been removed or suitable draws provided in same so as not to obstruct the navigation of said river.

The creek is crossed by nine county bridges and one railroad bridge, all without draws. That the appropriation might be lawfully applied to the improvement of the creek, the owners of the bridges have been

* Balance of $18.60 turned over to surplus fund.

requested to provide draws in them. This request has not been complied with, and the money has not, therefore, become applicable to the improvement of the creek to June 30, 1892, and no work whatever has been done upon it.

The appreciable benefit of clearing out Fishing Creek, which can be done principally with mules without a plant, will be restricted to a section of country extending but a short distance from its banks, and creeks as important are very numerous in the United States.

The creek is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1891, balance unexpended	$10,000.00
July 1, 1892, balance unexpended	10,000.00
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	15,000.00
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	*10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Fishing Creek, North Carolina.

Appropriated September 19, 1890, $10,000.

L 7.

IMPROVEMENT OF PAMLICO AND TAR RIVER, INCLUDING TAR RIVER FROM TARBORO TO LITTLE FALLS, NORTH CAROLINA.

The two names designate one river.

From its mouth in Pamlico Sound up 37 miles to Washington, N. C., it is a broad estuary and is called the Pamlico. Above Washington it soon narrows, becomes more distinctly fluvial in character, and is called the Tar to its source.

Appropriations for the two sections were made separately prior to 1880, and in one item since that date.

It rises near the easterly verge of the undulating or hilly section of North Carolina, and flows between the Roanoke and the Neuse across the level expanse of pine forests, differing little from those streams in its characteristics. From the falls, or rapids, at Rocky Mount to the Sound its length is 127 miles.

Its bed is generally of sand and soft material.

It flows at a distance of from 13 to 25 miles from the Roanoke on the north, and of 18 to 38 miles from the Neuse on the south.

Between Rocky Mount and Tarboro it is tortuous, the distance by river being 42 miles, while by an air line it is only 14 miles.

Freshets are frequent and sudden, having an extreme recorded rise of 20 feet at Rocky Mount, 22 feet at Greenville, and about 5 feet at Washington.

* This sum of $10,000 can be advantageously applied in the efficient and economical performance of the work, but it is not to be understood that it can, in the opinion of the district engineer, be applied with profit to the United States.

Near its mouth the lunar tides range about 12 inches, but are increased to 2 feet or more by the wind.

Its width increases from one-half mile at Washington to 4 miles at its mouth.

When the United States commenced to improve the river in 1877 the channel contained the following obstructions placed in it during the war: First, at Hills Point, about 6 miles below Washington, four rows of piles, the two lower rows being about 10 feet apart, and the two upper rows, driven in like manner, 150 yards from them; all were cut off 3 feet below water. Second, a short distance below Washington by two more rows of piles driven about one-quarter of a mile apart. Third, about one-quarter of a mile below Sparta by two lighters sunk in the channel, and fourth, 1 mile below Tarboro was the wreck of the steamer *Oregon*.

Above Washington the river was obstructed by snags, logs, and stumps in its channel, and by trees overhanging from its banks.

Its depth gradually diminished from 21 feet at its mouth to 8 feet immediately below the bar at Washington, which extended 7,400 feet below the lower wharf of the town, and upon which the depth at low water was 5 feet at a point half a mile below the wharf, and at other points 6½ to 7 feet, with intervals where the depth was 8 feet, but all of which were much diminished by the effect of the wind.

From Washington up 48 miles to Tarboro the available depth is reported to have been 2 to 3 feet eight months annually.

The projects of 1875 to secure by dredging and removal of war obstructions a clear and safe channel 9 feet deep at low water up to Washington, and of 1879 to clear a channel 60 feet wide, 3 feet deep at low water, 22 miles to Greenville, and 20 inches deep at low water 66 miles farther to Rocky Mount, by removing war obstructions, snags, logs, stumps, and overhanging trees, have been continued without modification.

Since the commencement of the improvement in 1877 the work accomplished has embraced the removal of all the war obstructions from the channel; the dredging in 1877 and 1878 through the sand shoal immediately below Washington of a channel 175 feet wide and 9 feet deep at ordinary low water, "to give 8 feet when the northwest winds caused extreme low water;" the dredging in 1878 to 1882 of a channel the same depth 108 feet wide through the shoal about 1 mile below Washington by the removal of about 1 foot of sand and mud and of large masses of roots and stumps beneath it; the construction in 1880 to 1884 along 19 miles of river, from a point 9 miles below to a point 28 miles below Tarboro, of upwards of 42 jetties, mostly of sheet piling, and in some instances of logs and brush, aggregating 6,684 linear feet; the clearing of the channel of snags, logs, and stumps, and the banks of leaning trees from Washington, 89 miles, to Rocky Mount.

A preliminary examination made by First Lieut. Mason M. Patrick, Corps of Engineers, in November, 1890, and survey by Assistant Engineer Charles Humphreys, October, 1890, to January, 1891, of the shoals at and 1 mile below Washington, show the channels dredged through them in 1877 to 1882 to have shoaled from 1 foot to 1.9 feet by deposit, principally of soft mud and sand, reducing the depth of the channel to a minimum of about 7 feet at low water.

In his supplemental report of February 21, 1891, based upon this survey, my predecessor, Capt. W. H. Bixby, Corps of Engineers, recommended redredging, straightening, and widening this channel to the depth of 9 feet and width of 200 feet, by the removal of 113,222 cubic yards, at an estimated cost of $45,000.

During the fiscal year ending June 30, 1892, the channel was cleared of snags, logs, and stumps, and the banks of leaning and overhanging trees from the falls at Rocky Mount down 40 miles to Tarboro, and from Tarboro 28 miles below it was fairly cleared of snags, logs, and stumps, as well as leaning trees which have accumulated since the last operations upon it. The number of snags, etc., removed and details of work done will be found in the appended report of Assistant Engineer W. H. Chadbourn, jr., who has been in immediate charge of the work since the death of Mr. Robert Ransom January 14, 1892, under whose immediate supervision the improvement had been for several years past.

At the date of this report the minimum depth in the channel on the shoals at and 1 mile below Washington is about 7 feet; at Red Banks, 20 miles above Washington and 2 miles below Greenville, there is a shoal which is very troublesome to steamers at low water, and at the mouth of Jerrys Creek, 43 miles above Washington and 5 miles below Tarboro, for a distance of 350 feet there is a shoal with a minimum depth of 1 foot at low water; the channel is well cleared of snags, logs, and stumps, and the banks of overhanging trees from Rocky Mount down about 68 miles to a point within 20 miles above Washington, whence to Washington it is quite badly obstructed. The work of removing these snags is in progress at the close of the fiscal year.

A draw is now being placed in the railroad bridge at Tarboro, but there is one highway bridge at Tarboro and two between Tarboro and Rocky Mount without draws.

The river above Tarboro is at present navigated only by a steam flatboat owned by the Farmers' Oil Mill Company, which makes about two round trips weekly between the cotton-seed oil mills of that company about 3 miles above Tarboro and Washington, carrying cotton seed upstream and oil downstream. Its capacity is about 50 tons.

The four principal towns on this river by the census of 1890 are Rocky Mount at the falls, having a population of 816; Tarboro with a population of 1,924; Greenville with a population of 1,937, and Washington with a population of 3,545.

From the census of 1890 it appears that in the three counties of Edgecombe, Pitt, and Beaufort there were grown in 1879, 47,150 bales of cotton from 94,812 acres, and in 1889, 31,032 bales from 108,709 acres.

On account of the indefinite extent of the work, the uncertainty as to the location and time when it should be done, and the frequent interruptions by freshets, the work was done by hired labor and the use of United States plant.

The river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1891, balance unexpended	$9,256.21
June 30, 1892, amount expended during fiscal year	6,148.39
July 1, 1892, balance unexpended	3,107.82
July 1, 1892, outstanding liabilities	832.67
July 1, 1892, balance available	2,275.15
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	12,275.15
Amount (estimated) required for completion of existing project	42,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	42,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF ASSISTANT ENGINEER W. H. CHADBOURN, JR.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report of operations on the Pamlico and Tar rivers for the fiscal year ending June 30, 1892:

Three hoisters and necessary quarters and flats were, on October 13 to 18, 1891, towed from Biddles Landing on Neuse River to Tarboro, on Tar River, and on 23d of same month work of warping plant to Rocky Mount (88 miles above Washington and head of navigation) was commenced, the plant removing from the stream the worst obstructions as it went up.

On account of low water in the river the plant did not reach Rocky Mount until December 4, 1891, and on account of high water laid up till January 26, 1892, since which time it has worked downstream 64 miles, removing to June 30, 1892:

From the channel:

Two thousand one hundred and sixty-one large snags, 343 stumps, 1,315 trees, 40 cords small snags, and 729 logs; and

From the banks:

Nineteen stumps, 623 cords small brush, 1,651 trees cut and pulled back, 2,015 logs cut and pulled back, and 517 trees trimmed.

Water-gauge observations have been kept at Rocky Mount during the year, and at Tarboro since May 8, 1892.

The result of the season's work is a very fair channel from Rocky Mount to Tarboro', and a thoroughly cleared channel from Tarboro to within 24 miles of Washington, being the part of the river most obstructed.

The river between Tarboro and Rocky Mount is obstructed by four bridges without draws, two of which at Tarboro are sufficiently high to permit small boats to pass under at ordinary stages of water. One of the bridges is now being rebuilt with a drawspan.

It is recommended that no further money be expended above Tarboro until the river is unobstructed by bridges and there is some navigation there.

It is believed that no funds will be required to clear the river between Tarboro and Washington during the next two years, and it is therefore recommended that any further appropriation be applied to dredging below Washington, and it is urged that a sufficient amount be appropriated to complete the project at once.

It will then, probably, be desirable to do some jettying between Tarboro and Greenville.

The following steamers are engaged in the commerce of the river, besides many sail vessels: The steamer *Pamlico*, 254 tons, made five trips during the year from Washington to Norfolk and return. The steamer *Annie*, 246 tons, made fifteen trips during the year from Washington to Norfolk and return. The steamer *Vesper*, 292 tons, has been making one trip per week since December 1, 1891, from Washington to Norfolk. The steamer *Albemarle*, about 500 tons, has been making two trips per week since November 1, 1891, between Washington and Norfolk. The steamer *Alpha*, 233 tons, and *Beaufort*, 385 tons, run irregularly from points on Lower Pamlico to Washington and Norfolk. The steamer *Greenville*, 68 tons, made three trips per week between Washington and Tarboro during part of the year. The steamer *R. L. Meyers*, 128 tons, makes three trips per week from Washington to Tarboro when height of water permits, and when not, to Greenville, or as far as she can go. The steamer *Delta*, 86 tons, has made irregular trips on the river. The steamer *Beta*, 57 tons, has done the same.

The steam tugs *Edith*, 19 tons, *E. S. Whittaker*, 25 tons, *Geo. M. Hill*, 26 tons, *J. W. Paxton*, 27 tons, *Josie*, 10 tons, *Lizzie Massey*, 23 tons, have towed on the river.

The expenses of the year have been:

Repairs to plant	$57.83
Purchase of property	10.50
Care of plant laying up	103.40
Water-guage observations	84.00
Superintendence and office expenses	971.55
Labor, supplies, towing, etc	5,410.92
Total	6,638.20

The operations on the river were under the immediate charge of Overseer Eugene J. Bell, who has rendered most faithful and efficient service and has my thanks for his untiring work.

Very respectfully, your obedient servant,

WM. H. CHADBOURN, JR.,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Total.	Tonnage.
Cotton and products	$1,000,000		$1,000,000	7,000
Tobacco	130,000		130,000	150
Rice	20,000		20,000	500
Grains and forage	3,000	$5,000	8,000	250
Vegetables and truck	130,000		130,000	4,500
Live stock and products	6,000	10,000	16,000	200
Fish, oysters, etc	150,000		150,000	8,000
Naval stores	15,000		15,000	1,000
Lumber and products	1,000,000		1,000,000	150,000
Coal and minerals		5,000	5,000	1,000
Fertilizers		100,000	100,000	2,000
Machinery		100,000	100,000	1,000
General merchandise	200,000	2,000,000	2,200,000	20,000
Total	2,654,000	2,220,000	4,874,000	195,600

The above statistics are based mainly upon reports of Assistant Engineer William H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Pamlico and Tar rivers, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
July 4, 1836, to July 7, 1838	$10,000	$10,000
August 14, 1876	15,000	15,000
March 3, 1879	6,000	21,000
June 14, 1880	9,000	30,000
March 3, 1881	8,000	38,000
August 2, 1882	10,000	48,000
July 5, 1884	5,000	53,000
August 5, 1886	5,000	58,000
August 11, 1888	10,000	68,000
September 19, 1890	10,000	78,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1837 to 1839	$10,000.00	$10,000.00
1877	363.96	363.96
1878	12,565.47	12,929.43
1879	1,209.80	14,139.23
1880	6,605.16	20,744.39
1881	8,392.24	29,136.63
1882	6,794.09	35,930.72
1883	3,932.75	39,863.47
1884	5,802.86	45,666.33
1885	4,870.77	50,537.10
1886	2,414.23	52,951.33
1887	3,161.28	56,112.61
1888	1,663.72	57,776.33
1889	6,832.20	64,608.53
1890	1,619.37	66,227.90
1891	2,565.23	68,793.13

Pamlico and Tar rivers, North Carolina—Continued.

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1876	21,000	$500,000
1878		2,190,000
1887		2,336,703
1888		2,888,744
1889		4,642,990
1890		4,670,810
1891	277,832	6,742,475

List of steamers navigating the Pamlico and Tar rivers, North Carolina, in the fiscal year ended June 30, 1892.

Names of steamers.	Net tonnage.	From—	To—	Number of trips yearly.
Pamlico	254	Washington	Norfolk	5
Annie	246	do	do	15
Vesper	292	do	do	28
Albemarle	37.60	do	do	64
Alpha	233	On lower Pamlico	Washington and Norfolk.	Irregular.
Beaufort	385	do	do	Do.
Greenville	68	Washington	Tarboro	3 trips per week part of year.
R. L. Myers	128	do	do	3 trips per week when height of water permits.
Delta	86	On river	On river	Irregular.
Beta	57	do	do	Do.
Edith *	19	do	do	Do.
E. T. Whittaker *	25	do	do	Do.
Geo. M. Hill *	26	do	do	Do.
J. W. Paxton *	27	do	do	Do.
Josie *	10	do	do	Do.
Lizzie Massey *	23	do	do	Do.

* Tugboats.

L 8.

IMPROVEMENT OF CONTENTNIA CREEK, NORTH CAROLINA.

It is the largest tributary to the Neuse River, into which it flows from the left bank 32 miles above Newbern.

At Stantonsburg, 63 miles by river (30 by land) from its mouth, the Contentnia becomes steeper in slope, narrows rapidly, "and is totally impassable even at mean low water;" thence to its mouth it is very tortuous, and when its improvement was commenced by the United States in 1881 it was "badly choked with fallen timber, sunken logs, and snags, also obstructed by sand bars and navigation rendered exceedingly difficult, in many places next to impossible, by the dense overhanging growth."

The project of 1881, continued without modification, is to clear it of overhanging trees and its channel of snags and logs to the depth of not less than 3 feet at the flush-water stages of eight or nine months' annual duration, at a cost estimated in 1888 at $77,500.

At the date of this report by the expenditure of upwards of $48,700, the channel to the depth of 3 feet had been moderately well cleared from the mouth 31 miles up to Snow Hill, and very roughly cleared the remaining 32 miles to Stantonsburg.

The traffic on the creek is by the steamer *Laura*, of 21 tons, making

from three to five trips per week to Snow Hill, and by the steamer *Nettie W.*, of 36 tons, making irregular trips to whatever point she can get freight. Considerable lumber is reported to be rafted down the creek, some of which is towed by the tug *Swan* to the sawmills at Newbern.

The extent and character of the traffic in detail will be found in the appended table of commercial statistics.

Work was suspended June 10, 1891, and has not been resumed during the fiscal year ending June 30, 1892.

The creek is now most obstructed near its mouth at Spring Slough, and considerably obstructed at other points below Snow Hill.

The $2,500 now available will be applied to improvement at these points during the ensuing season of low water.

A water-gauge record has been kept at Stantonsburg throughout the year.

For almost its entire course below Stantonsburg the creek flows about midway between, and 15 to 20 miles from, the Tar and Neuse rivers, which have been improved by the United States at a cost to this date of upwards of $65,000 and $265,000, respectively.

If it be the will of Congress to continue at a further estimated cost of about $30,000, and an aggregate estimated final cost of $77,500, an improvement so local in its appreciable benefits, the sum of $10,000 could be applied, so far as regards the economical execution of the work, with advantage during the fiscal year to end June 30, 1894.

The creek is in the collection district of Newbern.

Money statement.

July 1, 1891, balance unexpended	$3,588.90
June 30, 1892, amount expended during fiscal year	1,341.25
July 1, 1892, balance unexpended	2,247.65
July 1, 1892, outstanding liabilities	37.10
July 1, 1892, balance available	2,210.55
Amount appropriated by act approved July 13, 1892	7,000.00
Amount available for fiscal year ending June 30, 1893	9,210.55
Amount (estimated) required for completion of existing project	18,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$341,000	....	$341,000	2,500
Rice	10,000	....	10,000	45
Grains and forage	1,000	....	1,000	40
Vegetables and truck	20,000	....	20,000	500
Live stock and products	9,000	....	9,000	40
Naval stores	3,000	....	3,000	200
Lumber and products	200,000	....	200,000	45,000
General merchandise	50,000	$600,000	650,000	7,000
Total	634,000	600,000	1,234,000	55,325

Contentnia Creek, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
March 3, 1881	$10,000	$10,000
August 2, 1882	10,000	20,000
July 5, 1884	5,000	25,000
August 5, 1886	15,000	40,000
August 11, 1888	5,000	45,000
September 19, 1890	7,000	52,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1882	$9,693.99	$9,693.99
1883	9,435.89	19,129.88
1884	870.12	20,000.00
1885	3,268.61	23,268.61
1886	1,419.08	24,687.69
1887	9,331.40	34,019.09
1888	5,529.59	39,548.68
1889	3,829.34	43,378.02
1890	550.50	43,928.52
1891	4,772.98	48,701.50

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1885	....	$421,000
1887	....	639,550
1888	....	844,050
1889	....	1,203,500
1890	....	1,219,350
1891	125,225	1,342,100

L 9.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

The Trent is the principal tributary to the Neuse River, which it joins from the right bank at Newbern, N. C.

Its width is about 2,000 feet at Newbern, averaging between 450 and 2,000 in the lower 7 miles, and narrowing to about 350 feet in the lower 9 miles, and averaging about 175 feet thence to Pollocksville, 18 miles above Newbern, whence 20 miles to Trenton it varies between about 75 to 125 feet. From Trenton, 39½ miles to the Upper Quaker Bridge it varies from 10 to 160 feet, and averages about 62 feet.

Beginning at points respectively 27, 32½, and 37½ miles above Trenton there are stretches of narrows through cypress swamps, the first 3 miles in length, varying in width from 25 to 70 feet; the second 3½ miles in length, in which the width is 10 to 70 feet, and the third about 2 miles in length, where it is 12 to 50 feet.

Its minimum depth at lowest stages is 10 feet from Newbern to Pollocksville, 6 feet thence 7 miles to Quaker Bridge, and 3 feet thence 13

miles to Upper Quaker Bridge. It has a minimum depth in the narrows of 1½ feet.

Its banks are quite variable, frequently changing in character and height from cypress swamps to bluffs above overflow where the ground is timbered or cultivated. Above Trenton these bluffs are of various heights up to 60 feet, and below it they are 10 to 25 feet high. In the lower 9 miles between the bluffs there are salt marshes.

Its bed is generally sandy, with occasional rock shoals above Lower Quaker Bridge, and sand with mud toward and near the mouth.

Freshets overflow its bottom lands, and had, during the three years of gauge observations, 1889 to 1891, a recorded extreme rise of 17.6 feet at Trenton, 4.5 feet at Pollocksville, and 5 feet at Newbern.

Tides are perceptible a considerable distance above its mouth.

It is quite tortuous; the distance between Upper Quaker Bridge and Newbern, between which its length is 77½ miles, being only 32 miles by an air line. There are occasional groups of exceedingly sharp bends.

Pursuant to act of Congress of June, 1878, the river was surveyed from Newbern to Trenton in 1878.

Between Newbern and Pollocksville the river was then comparatively free from obstructions, and 6 feet of water could be carried at low summer stages. Above Pollocksville, and especially between the Lower Quaker Bridge and Trenton, it was badly obstructed by large quantities of snags in the channel, by fallen and overhanging trees, by occasional sand bars, and by one or more ledges of rock. One steamer ran regularly to Pollocksville, and one occasionally 9 miles farther to Quaker Bridge, above which navigation was confined to flatboats and rafts. Before the river had become so badly obstructed steamers made regular trips to Trenton.

The project of 1879 was to secure a channel 3 feet deep at extreme low summer stages from Pollocksville to Trenton by removing all obstructions and dredging to the width of 50 feet through the shoals; to divert the water from portions of old river beds by building 400 feet of solid dike, to protect the banks by 600 feet of wattle dam, and to cut off a bend 4 miles below Pollocksville, at an estimated cost of $22,000.

The quantities of snags and logs in the river proved so much greater than was expected, especially in the 14 miles next below Trenton, this estimate was increased in 1887 to $59,000.

The project of 1889 is to clear the river for navigation by small steamboats 33 miles above Trenton and by pole boats 6½ miles farther to Upper Quaker Bridge, at an increased cost of $13,000, the estimated cost of the project of 1879 as extended in 1889 being $72,000.

Work was commenced in September, 1879, and $41,464.06 were applied to June 30, 1886.

At that date a large number of snags and logs had been taken from the channel and the leaning trees cleared from the banks in the 14 miles between Quaker Bridge and Trenton, and the river had been cleared of snags, logs, and overhanging growth to Trenton from its mouth; a turning basin had been dredged at Trenton to 6 feet in depth at low water and revetted with wood; from the turning basin downstream a cut 4,300 feet long, 75 feet wide, and 3 feet deep at low water had been dredged; other dredging had been done on shoals between Trenton and Quaker Bridge, and some rock shoals blasted, the whole amount of dredging done in the river aggregating 77,825 cubic yards of material, besides upwards of 2,000 cubic yards of rock.

In 1887 six shoals of sand aggregating upwards of 800 feet in length had reformed in the 1½ miles next below Trenton.

In 1889 the snags were removed to the natural depth and a width of 300 feet for a distance of 1,700 feet entirely across Foys Flats, 6 miles above Newbern, and a channel 100 feet wide and 8 feet deep at dead low water (equal to that elsewhere in the river from Newbern to Trenton) was dredged through the flats by the removal of 14,677 cubic yards of material, besides many stumps and roots.

In 1891 the worst obstructions of recent accumulation were removed from the channel from the mouth to Trenton, and the 7 miles of river next above Trenton were fairly cleared by the removal of a large number of snags, logs, and stumps from its channel and leaning trees from its banks.

During the fiscal year ending June 30, 1892, the river has been surveyed from Trenton to Upper Quaker Bridge, but the funds available have been insufficient for other work in improving it.

At the date of this report, June 30, 1892, the river below Trenton is reported in very good condition with the exception of logs lost from rafts which cause occasional dangerous obstructions.

The commerce of this river is principally transported in one small steamboat, the *Howard*, of 63.79 tons, making, during the busy season, say six months of the year, two trips per week to Trenton and two others to Pollocksville, the other six months one trip to Trenton and two to Pollocksville.

The steamer *Trent*, 94 tons, makes irregular trips on the river, and the launch *Bloodgood* and several tugs are employed occasionally towing timber from the upper river to the sawmills near Newbern.

The shoals which have reformed immediately below Trenton prevent steamboats from ascending to that place at low water.

The part of the river under improvement flows through the middle of Jones County, which has an area of 450 square miles.

By the United States census its population was 7,491 in 1880, and 7,403 in 1890. In 1879 it produced 4,078 bales of cotton on 8,463 acres, and in 1889, 2,968 bales on 12,462 acres.

The river is in the collection district of Pamlico, N. C.

Money statement.

July 1, 1891, balance unexpended	$1,640.56
June 30, 1892, amount expended during fiscal year	1,031.84
July 1, 1892, balance unexpended	608.72
July 1, 1892, outstanding liabilities	25.50
July 1, 1892, balance available	583.22
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,583.22
Amount (estimated) required for completion of existing project	11,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$200,000		$200,000	1,200
Tobacco		$8,000	8,000	25
Rice	500	1,000	1,500	25
Grains and forage	1,800	2,500	4,300	200
Vegetables and truck	10,000		10,000	200
Live stock and products	2,000		2,000	25
Fish, oysters, etc	1,000		1,000	5
Naval stores	5,000		5,000	250
Lumber and products	250,000		250,000	40,000
Fertilizers		20,000	20,000	700
Machinery		5,000	5,000	50
General merchandise		150,000	150,000	2,300
Sundries	10,000	2,000	12,000	100
Total	480,300	188,500	668,800	45,080

Decrease since last year, 44,905 tons.

Transportation lines established during year, none.

The above statistics are based mainly upon reports of Assistant Engineer W. H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Trent River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
March 3, 1879	$7,000	$7,000
June 14, 1880	10,000	17,000
March 3, 1881	5,000	22,000
August 2, 1882	10,000	32,000
July 5, 1884	10,000	42,000
August 5, 1886	3,500	45,500
August 11, 1888	5,000	50,500
September 19, 1890	5,000	55,500

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1880	$6,871.63	$6,871.63
1881	10,279.80	17,151.43
1882	4,848.57	22,000.00
1883	1,597.38	23,597.38
1884	8,402.62	32,000.00
1885	9,329.56	41,329.56
1886	134.50	41,464.06
1887	567.67	42,031.73
1888	673.25	42,704.98
1889	6,867.40	49,572.38
1890	807.03	50,379.41
1891	3,517.66	53,897.07

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1879	22,000	$400,000
1884		445,900
1885		444,500
1887		650,000
1888		720,000
1889		971,750
1890		958,850
1891	89,985	1,352,925

L 10.

IMPROVEMENT OF NEUSE RIVER UP TO SMITHFIELD, NORTH CAROLINA.

Rising near the northerly boundary in the middle, hilly, or undulating belt of North Carolina, the Neuse flows southeasterly and, crossing the broad, low, comparatively level expanse of sandy soil covered with pine forests and intersected with cypress morasses, empties into Pamlico Sound.

The river is quite tortuous. While the air-line distance from Smithfield to Goldsboro is but 22 miles, by the river it is 62 miles, and the air-line distance from Smithfield to Newbern is 80 miles, while by the river it is 150 miles.

It is especially tortuous for a part of the distance between a point about 9½ miles below Goldsboro and the mouth of Contentnia Creek, for about 4 miles below Whitehall, and about 7¼ miles above Kinston for 5 miles, at all of which places there are series of very abrupt bends difficult for navigation.

Its course for about 25 miles in the region of Newbern is approximately parallel with and but 20 miles from the Pamlico and Tar River.

From a point above and near Newbern up 150 miles to Smithfield its width varies from 80 to 250 feet, being 130 feet at Smithfield and 80 feet near Goldsboro.

A few miles above Newbern it gradually widens into an estuary, spreading to a width of 5 miles at its mouth at Pamlico Sound, 40 miles below Newbern.

Freshets are frequent and sudden, having an extreme recorded rise of 15 feet at Smithfield, 20 feet at Goldsboro, and 17 feet at Kinston.

The height of the banks from Goldsboro to Contentnia Creek is 10 to 20 feet on the concave side, 3 to 6 feet on the convex side, and from Contentnia Creek to Newbern about 5 feet.

The banks and immediate bottom lands are for long distances densely timbered and frequently overflowed, but some of the lower bottoms, which are very fertile, have been reclaimed by dikes.

Plantations and houses are generally situated upon the uplands, 2 to 3 miles back.

The bed of the river is generally of coarse sand and gravel, but at Broadway Landing it consists of fine-grained slate, and near Fort Barnwell, about 28 miles above Newbern, of a conglomerate of shells.

About 2 miles below Smithfield, and also near Quaker Neck, there are Rock shoals, consisting of slaty rock covered with loose rock and bowlders.

In Pamlico Sound the water is salt. The estuary portion of the river has a lunar tide of 4 to 8 inches, but its surface fluctuates with the wind from 1 to 5 feet.

In 1856–'57 the State of North Carolina improved the navigation of the river by the construction of wing dams and by the removal of snags and fallen and leaning trees between the mouth of Contentnia Creek and Pitch Kettle, 21 miles above Newbern.

Before the war steamers are said to have made regular trips from Goldsboro up 62 miles to Smithfield, a village having by the census of 1890 a population of 550. It is said to be the center of a fairly productive country.

When the United States commenced its improvement in 1878 the navigation of the river was obstructed by war blockades at four points, namely: First, at Johnson's Point, 4 miles below Newbern, by a row

of "Yankee catchers," which consisted of inclined spars secured to cribs or boxes filled with stone, their points shod with iron and submerged below low water; second, at Fort Point, 3 miles below Newbern, by another row of "Yankee catchers" planted a short distance below a line of vessels filled with stone and scuttled and flanked with piles; third, at Batchelder Creek, 3 miles above Newbern, by a row of sunken cribs, barges, and vessels filled with stones; and fourth, at Southwest Blockade, 7 miles below Kinston, by two rows of sunken cribs filled with stones arranged checkerwise across the channel.

Below Contentnia Creek the remains of a cofferdam constructed for building the foundations of a lock, never completed, formed a formidable obstruction.

During nine months of the year the minimum channel depth is reported to have been: From the mouth 40 miles to Newbern, 9 feet; from Newbern 50 miles to Kinston, 4 feet; from Kinston 46 miles to Goldsboro, 3 feet, and thence 53 miles to Smithfield, 2 feet.

Between Newbern and Kingston, however, there were long stretches of shoals, upon at least one of which the depth during the low-water season was only about 18 inches.

From Contentnia Creek up 119 miles to Smithfield the river was badly obstructed by overhanging trees and by dense masses of logs and snags which gradually accumulate in the river by the cutting of the banks at the sharpest bends.

The project of 1871, modified or extended in 1878, 1879, 1880, and 1883, and continued without modification since the latter date, proposed to remove the war obstructions, to clear the channel up to Smithfield of all snags, logs, and overhanging trees, "and to contract the channelway by jetties so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to Newbern and a similar 4-foot navigation 50 miles farther to Kinston, and during nine months of the year a 3-foot navigation 100 miles farther to Smithfield," at a total final cost estimated in 1888 at $374,000.

Work commenced in 1878, when a channel 300 feet long, 100 feet wide, and 8 feet deep was dredged through the bar at Newbern. The war obstructions have all been removed. The channel has been cleared of snags, logs, and stumps, and the banks of overhanging trees from Contentnia Creek up to Smithfield. Between Kinston and Newbern 54,862 linear feet of jetties of piles, and in a few instances of logs and brush, have been built perpendicular to the bank to direct the channel on the shoals.

During the fiscal year ending June 30, 1892, the channel and banks of 23 miles of the river immediately above Kinston, and of 23½ miles between Kinston and Newbern, were cleared of snags, logs, and stumps, and overhanging trees, leaving a cleared channel from 120 to 250 feet wide and 3 to 12 feet deep, the details of which work will be found in the appended report of Assistant Engineer W. H. Chadbourn, jr., to whom the immediate charge of the work has been intrusted during the latter half of the year since the death of Mr. Robert Ransom, who for many years past was in immediate charge of this work until his death, January 14, 1892.

At the date of this report the channel and banks, at least below Goldsboro, are reported to be well cleared of snags, logs, and stumps, and overhanging trees, and the river in that respect in good navigable condition.

The shoalest part of the river below Kinston extends from a point 18 miles above Newbern to a point about 7 miles below Kinston, within which distance of 25 miles there are nine shoals varying from 150 to 600

feet and aggregating 3,150 feet in length, upon some of which the depth at low water is 1½ feet and on others about 2½ feet.

At one of these shoals freight steamers at low-water stages have to transfer their freight to light-draft flats, and another just below the most important landing on the river between Newbern and Kinston is reported to cause serious inconvenience.

On account of the cost of stone, jetties hitherto constructed on the river have been built principally of piles, which soon decay and during freshets are, to some extent, washed out or destroyed by drift wood. The opening of quarries and construction of railroads within the past two years have materially reduced the price at which stone can be delivered at Kinston and Newbern, and it is believed it can now be purchased sufficiently low to permit its use in building jetties of stone upon brush mattresses, to which purpose the $8,650 now available will be applied during the ensuing low-water season in improving the channel upon the worst of the shoals above described.

During the fiscal year to end June 30, 1894, it is estimated that the sum of $20,000 can be advantageously applied to the construction of jetties and to keeping the channel and banks clear below Goldsboro.

In the report of June 30, 1891, it is stated that the estimated amount required for completion of the existing project is $106,500. A sufficient examination of the river to revise this estimate has not yet been made, but will be during the ensuing year.

On account of the indefinite extent of the work, the uncertainty as to the location and time when it should be done, and the frequent interruptions by freshets, the work was done by hired labor and the use of United States plant.

The river is in the collection district of Pamlico, N. C.

Money statement.

July, 1, 1891, balance unexpended	$14,874.45
June 30, 1892, amount expended during fiscal year	6,149.63
July 1, 1892, balance unexpended	8,724.82
July 1, 1892, outstanding liabilities	23.90
July 1, 1892, balance available	8,700.92
Amount appropriated by act approved July 13, 1892	15,000.00
Amount available for fiscal year ending June 30, 1893	23,700.92
Amount (estimated) required for completion of existing project	91,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. W. H. CHADBOURN, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1892.

MAJOR: I have the honor to submit the report of operations for improving Neuse River, North Carolina, for the fiscal year ending June 30, 1892.

Two hoisters and necessary quarters and flats under Overseer Eugene J. Bell worked over 23 miles of river (seventy-third to fiftieth mile post) between July 1 and October 3, and one hoister and necessary quarters and flats under Overseer Herman Bryan worked over 23½ miles of river (forty-six and a half to twenty-three mile post) between July 1 and August 4, 1891.

The combined plant removed from the channel 684 large snags, 508 stumps, 9 old piles, 322 trees, 23 cords small snags, and 368 logs; and from the banks 336 snags, 96¼ cords small brush, 2,026 logs cut and rolled back, 802 trees cut and pulled, and 2 trees trimmed. Channel cleared from 120 to 250 feet wide and 3 to 12 feet deep.

A water gauge was kept at Smithfield, N. C., during the year.

The river at present is in excellent condition so far as snags and logs, etc., are concerned, and it is not probable that it will require any work of snagging and clearing during the next two years at least.

It is proposed to expend the balance of the money now available in jettying where boats have the most trouble during low water, and it is also proposed to do the jettying with stone, as the wooden sheet-pile jetties are so easily destroyed during freshets.

With the improvement of Ocracoke Inlet it is very probable that the needs of commerce will call for a deeper channel in the Lower Neuse below Newbern.

The commerce of the river is carried by the following steamers and many large schooners and smaller sail vessels:

The steamer *Neuse*, 489 tons, makes from three to four trips per week from Newbern to Elizabeth City and return. The steamer *Plymouth*, 210 tons, made five trips during year from Newbern to Elizabeth City, while *Neuse* was undergoing repairs. The steamer *Vesper*, 292 tons, made four trips during the year from Newbern to Baltimore and return. The steamer *Geo. H. Stout*, 334 tons, makes one trip weekly from Newbern to Baltimore and return. The steamer *Newbern*, 344 tons, made three trips weekly from Newbern to Norfolk and return. The steamer *Defiance*, 421 tons, made one trip weekly from Newbern to Baltimore and return. The steamer *T. M. Southgate*, 146 tons, made one trip during the year while the steamer *Newbern* was being repaired. The steamer *J. C. McNaughton*, 146 tons, made one trip to Newbern, bringing fertilizers. The steamer *Eaglet*, 339 tons, has made six trips during the year since March 1 to Baltimore and return. The steamer *Cenola*, 194 tons, makes 1 trip per week (since May 1) from Newbern to Norfolk and return. The steamer *Sadie M. Rand*, 101 tons, made irregular trips on the Upper Neuse during high-water season. The steamer *Carolina*, 29 tons, makes two trips per week to Vanceboro, on Sugar Creek, leaving the Neuse 9 miles above Newbern. The steamer *L. H. Cutler*, 42 tons, makes five trips up Swift Creek. The steamer *Vanceboro*, 91 tons, has run irregularly during the year up Swift Creek. The steamer *R. E. Lee*, 69 tons, runs irregularly on the river three and a half months during the year. The steamer *Kinston*, 102 tons, makes two trips per week to Kinston when water will permit. The steamer *Laura*, 21.17 tons, makes from three to five trips per week to Contentnia Creek. The steamer *Nettie W.*, 36 tons, has made irregular trips during the year. The steamer *L. A. Cobb*, 49 tons, made from two to three trips per week to Contentnia Creek. The steamer *Trent*, 94 tons, makes two trips per week down Neuse River to Adams Creek. The steamer *Virginia*, 30 tons, is used on the lower river freighting lumber.

The tugs *Glide*, 30 tons, *Ella*, 30 tons, *Hygira*, 24 tons, and *Swan*, 24 tons, are employed in the river in principally taking timber from the upper and lower river to Newbern.

It will be seen by the above fleet of vessels plying on this river that the estimates of the commerce of this stream are well within the probable total amount.

The expenses of the year have been:

For construction and repair of plant	$424.50
Purchase of property (rope, tools, etc.)	37.13
Care of plant laying up	318.25
Water gauge observations	72.00
Superintendence and office expenses	873.70
Labor and supplies	3,278.77
Total	4,604.35

Very respectfully, your obedient servant,

W. H. CHADBOURN, JR.,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$1,500,000		$1,500,000	10,000
Tobacco		$30,000	30,000	75
Rice	20,000		20,000	445
Grains and forage		30,000	30,000	1,500
Vegetables and truck	400,000		400,000	17,000
Live stock and products	10,000	15,000	25,000	130
Fish, oysters, etc	300,000	100,000	400,000	24,000
Naval stores	100,000		100,000	3,500
Lumber and products	1,000,000		1,000,000	150,000
Coal and minerals		15,000	15,000	3,000
Fertilizers		125,000	125,000	5,000
Machinery		50,000	50,000	500
General merchandise		3,750,000	3,750,000	47,500
Sundries	200,000	100,000	300,000	5,000
Total	3,530,000	4,215,000	7,745,000	267,650

Neuse River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
June 18, 1878	$40,000	$40,000
March 3, 1879	45,000	85,000
June 14, 1880	45,000	130,000
March 3, 1881	30,000	160,000
August 2, 1882	30,000	190,000
July 5, 1884	20,000	210,000
August 5, 1886	22,500	232,500
August 11, 1888	15,000	247,500
September 30, 1890	20,000	267,500

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1879	$29,321.11	$29,321.11
1880	37,433.79	66,754.90
1881	38,379.15	105,134.05
1882	43,473.39	148,607.44
1883	23,611.07	172,218.51
1884	11,918.52	184,137.03
1885	12,131.27	196,268.30
1886	9,557.42	205,825.72
1887	14,214.66	220,040.38
1888	5,977.22	226,017.60
1889	7,250.17	233,267.77
1890	12,230.66	245,498.43
1891	8,402.43	253,900.86

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1878	75,000	$2,000,000
1885		1,045,000
1887		1,810,300
1888		2,466,850
1889		4,300,000
1890		6,469,103
1891	328,462	8,312,205

List of steamers navigating the Neuse River, North Carolina, in the fiscal year ended June 30, 1892.

Names of steamers.	Net tonnage.	From—	To—	Number of trips yearly.
Neuse	487.04	Newbern	Elizabeth City	354
Plymouth	210.15	......do	......do	10
Vesper	292.36	......do	Baltimore	8
Geo. H. Stout	234.08	......do	......do	104
New Berne	344.52	......do	Norfolk	310
Defiance	424	......do	Baltimore	104
T. M. Southgate	344	......do	Norfolk	2
J. C. McNaughton	146	......do	Baltimore	2
Cenola	194	......do	Norfolk	18
Sadie McRand	101	......do	River	Irregular.
Carolina	39	9 miles above Newbern.	Vanceboro	208
L. H. Cutler	30.49	Newbern	Swift Creek	10
Vanceboro	52.41	......do	......do	Irregular.
R. E. Lee	69	......do	River	Irregular 3½ months.
Kinston	97.43	......do	Kinston	156
Laura	14.09	......do	Contentnia Creek	416
Nettie W	18.40	......do		Irregular.
L. A. Cobb	49	......do	Contentnia Creek	260
Trent	75.97	......do	Adams Creek	208
Virginia	19.60	......do	Freighting lumber on river.	Irregular.
Glide	20.94	......do	......do	Do.
Ella	15.45	......do	Taking timber from upper and lower river.	Do.
Higgins	12.74	......do	......do	Do.
Swan	12.16	......do	......do	Do.

L 11.

IMPROVEMENT OF INLAND WATERWAY BETWEEN NEWBERN AND BEAUFORT HARBOR, NORTH CAROLINA, VIA CLUBFOOT, HARLOWE, AND NEWPORT RIVERS.

This waterway extends from Newbern down the Neuse River 21 miles, up Clubfoot River 5 miles, through the Clubfoot and Harlowe Canal 3 miles, down Harlowe River 4 miles and Newport River 6 miles to Beaufort Harbor, an aggregate distance of 39 miles.

The other inland waterway, from Newbern via the Neuse to its mouth, Pamlico and Core sounds, to Beaufort, is 90 miles long, and the draft of water that can be carried through it is restricted to 5 feet on the shoal in Core Sound.

The canal route, therefore, saves a distance of 49 miles between Newbern and Beaufort, and is very useful for small vessels and in controlling freight rates by the railroad nearly parallel with it and 36 miles long (only 3 miles shorter) from Newbern to Beaufort.

Lumber, oysters, cotton, and other products of the vicinity of Bogue and Core sounds are carried through the canal route to reach at Newbern the nearest freight line by steamers to Atlantic coast ports; and household goods, some agricultural implements, and fertilizers pass from the terminus of the steam freight line at Newbern through the canal route for distribution in return for the products exported.

The following quotations are from the annual report for the fiscal year ending June 30, 1891, of Capt. W. H. Bixby, Corps of Engineers, then in charge of this work:

The inland line of navigation from Newbern to Beaufort Harbor via Clubfoot, Harlowe, and Newport rivers was established by the State of North Carolina in about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned.

About 1880 the line was reopened by the Newbern and Beaufort Canal Company. When placed under Governmental improvement in 1885 this route allowed the passage of small boats of 15 feet width and 3-foot draft; but the commerce was then practically nothing.

The original project of 1883 reported this route via Clubfoot, Harlowe, and Newport rivers as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward, and estimated the cost of a channel 80 feet wide and 9 feet deep at $883,580, increased by the cost of a tide lock and the canal company's franchise. A modified project of 1884 for the expenditure of the funds at that time available as continued to date proposed to widen and deepen Harlowe Creek so as to secure a through canal of 5-foot depth at mean low water and of 30-foot bottom width from the mouth of Harlowe Creek upward 4 miles to its head, and to use the remaining funds upon similar works on Clubfoot River.

The total final cost of the latter (1884) project (including also the completion of the canal) so as to secure a channel 30 feet wide and 5 feet deep at low water from the Neuse River through to Newport River, adapted to the existing navigation of the Neuse River desiring passage by this route to Beaufort Harbor, was estimated in 1886 to be $92,000.

Up to June 30, 1890, a total of $26,603.12, including outstanding liabilities, had been spent in all upon this improvement, on necessary surveys, in removing the worst logs and stumps from the existing channel, in dredging an excellent channel 13,000 feet long, 30 feet wide, and 5 feet deep at low water through the worst portions of Harlowe Creek, thus securing a far better navigation through this creek than exists through the Newbern and Beaufort Canal to which it leads.

In consequence of this, several hundred sailboats had passed through the canal, and the commerce of this route had already reached about $200,000 per year, and is rapidly increasing.

The funds at present available have been retained to await developments as to the proposed action of the corporation owning the Newbern and Beaufort Canal, connecting Harlowe Creek with Clubfoot Creek. Verbal statements of the former president of this canal company and of the present governor of the State of North Carolina tend to show that the canal company has in the past few years received from the State of North Carolina a present of enough money to put the canal in good navigable condition; but that it was not willing to cede even the canal to the United States, except in return for an additional large sum of money.

In his report above cited Capt. Bixby recommended "that no new funds be made available until this canal shall be ceded to the United States free of charge."

No work has been done during the fiscal year ending June 30, 1892, or since its suspension in August, 1890, "awaiting cession of the canal."

At the date of this report, June 30, 1892, the canal has been so improved by the corporation owning it that a depth of 3 feet, it is said, can now be carried through it at low water. In Clubfoot River there is a shoal about one-half mile long on which there is about 2½ feet at low water, and some sunken logs in the channel which are dangerous to navigation. In Harlowe Creek at the narrows there is a shoal about 1 mile in extent, on which there is a depth of somewhat less than 2 feet at low water.

In addition to the work to June 30, 1890, above summarized, it appears that upwards of 3,400 linear feet of board jetties riprapped with oyster shells were built upon this shoal which, it is reported, are having the effect of slowly increasing the depth of water upon it.

By the census of 1890 the population of Newbern is 7,843, and of Beaufort 2,007.

The terms upon which the United States can secure the control of the canal from the corporation owning it will be ascertained as early as practicable, and a special report will then be made upon the improvement of this waterway.

The waterway is in the collection district of Pamlico and Beaufort, N. C.

Money statement.

July 1, 1891, balance unexpended	$7,920.60
June 30, 1892, amount expended during fiscal year	50.58
July 1, 1892, balance unexpended	7,870.02
July 1, 1892, outstanding liabilities	1.00
July 1, 1892, balance available	7,869.02
Amount (estimated) required for completion of existing project	57,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	(*)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$46,000		$46,000	290
Tobacco		$5,000	5,000	25
Rice	10,000	1,000	11,000	250
Grains and forage	500	7,500	8,000	480
Vegetables and truck	10,000		10,000	460
Live stock and products	2,000		2,000	15
Fish, oysters, etc	30,000		30,000	3,280
Naval stores	12,000		12,000	470
Lumber and products	25,000		25,000	8,600
Coal		500	500	100
Fertilizers	1,500	3,000	4,500	220
Machinery and hardware		15,000	15,000	500
General merchandise	5,000	60,000	65,000	2,100
Sundries	1,000	2,000	3,000	600
Actually passing over this waterway	143,000	94,000	237,000	17,390
Commerce through Core Sound which would have passed over this waterway had canal been open	50,000	53,000	103,000	7,610
Grand total	193,000	147,000	340,000	25,000

Gain over last year, $50,000; tons, 11,000.

Transportation lines established during year, none.

The above statistics are based mainly upon reports of Assistant Engineer W. H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Inland waterway between Newbern and Beaufort, N. C.

APPROPRIATED.

Date.	Amount.	Aggregate.
August 2, 1882	$10,000	$10,000
August 5, 1886	10,000	20,000
August 11, 1888	15,000	35,000

* Further work having been postposed (Annual Report, Chief of Engineers, 1891, page 161) to await cession or sale of the canal to the United States, no further appropriation is required until such cession or sale is made.

Inland waterway between Newbern and Beaufort, N. C.—Continued.

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1884	$194.40	$194.40
1885	1,879.91	2,074.31
1886	131.45	2,205.76
1887	1,293.49	3,499.25
1888	3,313.20	6,812.45
1889	17,430.00	24,242.45
1890	2,360.67	26,603.12
1891	476.28	27,079.40

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1888	....	$200.000
1889	....	202.330
1890	....	199,925
1891	14,000	290,000

L 12.

IMPROVEMENT OF HARBOR AT BEAUFORT, NORTH CAROLINA.

It is the only harbor of importance between Chesapeake Bay and the mouth of the Cape Fear River, a distance of over 300 miles.

The depth in the channel on its bar is now reported by pilots to be 12 feet at mean low water.

It has direct water communication by Back and Core sounds through which about 5 feet of water may be carried by an experienced pilot to Pamlico Sound, by Bogue Sound with a depth of 3 feet, 24 miles west to Bogue Inlet and Swansboro, and by Newbern and Beaufort Waterway with the same depth of 3 feet 39 miles to Newbern on the Neuse River. It is the terminus of the Atlantic and North Carolina Railroad joining the Atlantic Coast Line at Goldsboro, and is frequently sought by coasting vessels as a harbor of refuge.

Its entrance from the ocean is an inlet through the narrow stretch of sandy beach interposed between the ocean and the succession of shallow sounds characteristic of the coast of North Carolina.

From the harbor immediately within the entrance Back Sound and beyond it Core Sound stretch to the east, Bogue Sound extends to the west, and Newport River to the north, all embracing extensive shoals and few and mostly shallow channels.

The main harbor channel extends from the bar on an easy curve two miles to the railroad wharves at Morehead City, about north by west from the entrance, with a mid-channel depth of 22 to 34 feet at mean low water, and a width varying from 100 to 300 yards between the 18-foot curves.

Branching, about one-half mile within the bar, from the main channel to the north is Bulkhead Channel, with a mid-channel depth of 7 to 13 feet at mean low water for about 3,600 feet, interposed between which and the wharves at Beaufort is a shoal about 1,800 feet across, upon which there is "from 2 to 3 feet of water at mean low tide."

Above Morehead City the main channel extends for a depth of 14 to 25 feet northeasterly $1\frac{1}{2}$ miles, and is then soon lost in the broad and shallow expanse of Newport River.

Outside of the main and bulkhead channels "the harbor is full of shoals traversed by narrow and intricate slues."

This harbor was first improved by the United States in 1836 by the application of $5,000 in a manner unknown to this office.

When its improvement was resumed in 1881 the erosion of Fort Macon Point on the east and of Shackleford Point on the west, and widening of the entrance between, caused serious shoaling of the channel on and inside the bar, across which there was then a mid-channel depth of not less than (Annual Report, Chief of Engineers, 1891, page 161) 15.3 feet at low water, the tidal range being 3 feet.

The project of 1881 was to stop the erosion at Fort Macon and Shackleford points by jetties to prevent the widening and shoaling of the bar channel and shoaling of the harbor by deposit of material eroded from these points; to dredge a channel 200 feet wide and 9 feet deep at low water from the Bulkhead Channel 1,950 feet to the wharves at Beaufort, and a channel 100 feet wide and 6 feet deep at mean low water from the 6-foot contour at Beaufort down the Old Town Channel and north of Horse Island to the 6-foot contour in the channel leading to North River, a distance of 12,670 feet.

The project of 1887 modified the foregoing by reducing to the width of 100 feet and depth of 5 feet the channel to be dredged from the bulkhead channel to Beaufort, and by postponing for the present the dredging of the cut through the Old Town Channel to North River.

In 1890 the project was again modified by increasing to the depth of 7 feet the channel to be dredged from the Bulkhead Channel to the wharves at Beaufort at an estimated final cost of $163,000.

Work was commenced in 1882 and prior to the fiscal year just closed, by the construction of a concrete jetty 6 feet wide and 495 feet long at Shackleford Point, and 6 feet wide and 386 feet long at Fort Macon Point, of jetties of riprap stone and sand-catching fences, the erosion of the two points was arrested and Shackleford Point advanced 600 and Fort Macon Point 300 feet. Two short bulkheads were built to prevent the Newport River from cutting west of Fort Macon through the sand beach and forming a new inlet from the ocean to the harbor. In 1889 a channel 50 feet wide and 5 feet at mean low water was cut from the Bulkhead Channel to the deep water anchorage at the Beaufort wharves.

For widening this channel, about 1,800 feet long, to 100 feet, and deepening it to 7 feet, contract at $33\frac{1}{4}$ cents per cubic yard measured in scows was entered into with the Alabama Dredging and Jetty Company, December 24, 1890, and approved January 27, 1891, for dredging, to commence on or before July 3, 1891, or upon the completion of dredging by the same company in Bogue Sound. July 8, 1891, the time for completion of the contract was extended to April 3, 1892, and on April 23 it was again extended to June 30, 1892. Work was commenced April 30, 1892, with a suction dredge discharging the material, which is sand, upon the shoal 100 feet from the northerly and westerly edge of the cut. The work is still in progress, and to June 30, 1892, 9,989.22 cubic yards of material have been removed, making a cut 35 to 100 feet wide and 714 feet long.

This dredging and minor repairs to sand fences are all that has been done during the year.

The channel across the bar at the entrance to the harbor is change-

able. In the Annual Report of the Chief of Engineers for 1891, page 161, its depth is stated to have been in 1880 15.3 feet. The Atlantic Coast Pilot of 1885 says of it: "At times there have been 14 feet or more at low water; in January, 1884, there was 12½ feet to be found, while in June, 1888, there was only 11 feet at low water, with an average rise of the tide of 2.8 feet. With exceptionally high tides vessels drawing 17½ feet of water have been taken out over the bar."

Pilots report that this channel is steadily narrowing and that another and wider channel is forming with an outlet to the south, in which there is now on the crest of the bar 11 feet at mean low water.

By the United States census the population of Beaufort in 1880 was 2,009 and in 1890 2,007, and the population of Morehead City in 1880 was 520 and in 1890, 1,064.

By the same census the number of bales of cotton raised in Carteret County, in which this harbor is situated, was, in 1859, 4; in 1869, 774; in 1879, 1,014, upon 2,936 acres, and in 1889, 600 bales upon 2,600 acres.

No regular lines of steam or other vessels enter this harbor.

The work in this harbor during the year has been under the immediate and efficient supervision of Assistant Engineer W. H. Chadborn, jr., whose report is appended.

Beaufort is a port of entry.

Money statement.

July 1, 1891, balance unexpended		$16,459.51
June 30, 1892, amount expended during fiscal year		2,412.56
July 1, 1892, balance unexpended		14,046.95
July 1, 1892, outstanding liabilities	$2,402.26	
July 1, 1892, amount covered by uncompleted contracts	8,670.26	
		11,072.52
July 1, 1892, balance available		2,974.43
Amount appropriated by act approved July 13, 1892		10,000.00
Amount available for fiscal year ending June 30, 1893		12,974.43
Amount (estimated) required for completion of existing project		13,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		13,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF ASSISTANT ENGINEER W. H. CHADBOURN, JR.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report upon the improvement of the harbor at Beaufort, N. C., during the fiscal year ending June 30, 1892.

Under contract dated December 24, 1890, with the Alabama Dredging and Jetty Company dredging commenced April 21, 1892, at the extreme westward end of the cut through the shoal immediately in front of Beaufort, with a small pump dredge.

Up to date 9,989.22 cubic yards of sand have been removed from this shoal, nearly completing the first tangent of the cut to 100 feet width and 7 to 8 feet depth at low water.

By the contract the material was to be deposited in scows, but the contractors have been allowed to place the dumpage on the shoal immediately north of the cut and 100 feet distant from the northward edge of cut.

It is believed that the dumpage so placed will tend to throw more current in the channel and thus tend to prevent its shoaling, and it is not thought that the dumpage will be at all likely to wash back into the cut.

The material is measured in situ, and the number of yards so determined increased 25 per cent to equal scow measurement, as per ratio established in the contract.

The contract is barely one-third completed.

The sand fences at Fort Macon and Shackleford points have received such attention as they needed. They have built the beach up considerably at both places, and consequently the condition of both points is much stronger.

All the jetties are in good condition.

The pilots report the bar in the poorest condition for years. The old or main bar, the one used for many years and buoyed out, has narrowed and shoaled until now there is reported by the pilots to be only 12 feet there at mean low water, and very narrow between the shoals on either side and constantly narrowing.

Much nearer the beach line than this bar and just at the knuckle in the channel a new channel seems to be forming with outlet to southward, and pilots report 11 feet now on this bar and very much wider than the old bar. I think this will shortly be the best entrance.

This is an advantage, as experience with these sand bars shows the more southerly the direction of the channel they are deeper and more permanent.

There are no regular steamer lines entering this harbor. The steamer *Nellie B. Dey*, 66.24 tons, and *William Floyd*, 57.37 tons, are engaged in the fishing business and are constantly running in and out of the harbor.

This harbor is also very frequently used by coasting vessels as a harbor of refuge, and many sail vessels from small size up to 500 tons carry cargoes in and out.

During the year minor surveys have been made of the low-tide beach line at Shackleford Point.

The expenses of the year under my direction have been:

Purchase and repair of plant	$168.85
Manual labor	171.76
Dredging	3,329.74
Superintendence and surveys	697.06
Total	4,367.41

Dredging operations were carried on under the immediate supervision of Mr. J. B. Ives, to whom my thanks are due for this and also for much other general assistance.

Very respectfully, your obedient servant,

W. H. CHADBOURN, JR.,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
Cotton and products	$60,000	....	$60,000	500
Tobacco	12,000	$16,000	28,000	60
Rice	3,000	1,500	4,500	70
Grains and forage	1,750	21,500	23,250	600
Vegetables and truck	77,250	....	77,250	2,300
Live stock and products	32,000	10,000	42,000	450
Fish, oysters, etc	387,500	100,000	487,500	28,000
Naval stores	13,000	....	13,000	550
Lumber and products	2,000	16,000	18,000	6,600
Coal and minerals	....	10,000	10,000	2,000
Fertilizers	26,000	100,000	126,000	5,000
Machinery	1,000	8,000	9,000	100
General merchandise	250,000	340,000	590,000	4,400
Sundries	2,000	36,000	38,000	8,700
Total	867,500	659,000	1,526,500	59,330
Passing through the harbor	500,000	500,000	1,000,000	10,000
Total	1,367,500	1,159,000	2,526,500	69,330

Gain over last year, $202,000; tons, 22,655.

Transportation lines established during year, none.

The above statistics are based mainly upon reports of Assistant Engineer W. H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Beaufort Harbor, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
July 4, 1836	$5,000	$5,000
March 3, 1881	30,000	30,000
August 2, 1882	25,000	55,000
July 5, 1884	20,000	75,000
August 5, 1886	15,000	90,000
August 11, 1888	35,000	125,000
September 19, 1890	15,000	140,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1837	$5,000.00	$5,000.00
1882	4,102.91	4,102.91
1883	33,827.70	37,930.61
1884	5,870.43	43,801.04
1885	28,980.40	72,781.44
1886	2,218.56	75,000.00
1887	8,086.19	83,086.19
1888	5,783.29	88,869.48
1889	13,103.14	101,972.62
1890	20,061.81	122,034.43
1891	1,638.91	123,673.34

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1881	25,000	$1,000,000
1885		1,000,000
1886		1,021,670
1888		1,300,000
1889		1,688,525
1890		2,154,000
1891	46,675	2,324,500

L 13.

IMPROVEMENT OF INLAND WATERWAY BETWEEN BEAUFORT HARBOR AND NEW RIVER, NORTH CAROLINA.

This waterway lies between the mainland and the narrow strip of sand interposed between the ocean and the chain of sounds that skirts nearly the entire coast of North Carolina.

From Beaufort west about 24½ miles, embracing nearly all of Bogue Sound, the area between the sand barrier and the mainland is an expanse of shoal water; thence about 19½ miles to New River it is a broad marsh threaded by a tortuous and shoal tide-water creek.

The funds appropriated for "improving the inland waterway between Beaufort and New River, North Carolina," have been applied exclusively to the improvement of that part of it in Bogue Sound from Beaufort 27 miles west to Bogue Inlet, opposite Swansboro on the mainland. The improvement of the tide-water creek from Swansboro through the marsh to New River was, by the act of September 19, 1890, provided

for in a separate appropriation for "improving the waterway between New River and Swansboro, N. C.," and will be reported upon under that appropriation.

Bogue Sound is about half a mile to 2½ miles in width. For about 5 miles from its easterly end there is a narrow channel 10 to 16 feet deep; elsewhere its depth ranges from about 18 inches to about 6 feet.

When the United States began to improve the section through Bogue Sound from Beaufort to Swansboro in 1888 the depth in the channel was not less than 3 feet, except upon several shoals aggregating upwards of 4 miles in length, through which not more than 18 inches could be carried at low water.

The project of 1885, not since modified, designed to secure, at a cost estimated in 1887 at $50,000, a channel not less than 3 feet deep at mean low water from Beaufort to Swansboro by dredging a cut 100 feet wide an aggregate length of 21,385 feet (4.05 miles) on shoals as follows: 1,200 feet through Sally Bell Shoal, 8 miles from Beaufort; 13,700 feet through Sanders Creek Shoal, 18 miles from Beaufort; 3,630 feet through Goose Creek Shoal, 21 miles from Beaufort; 1,840 feet through Turtle Slough Shoal, 23 miles from Beaufort; and 1,015 feet through Cross Stakes Shoal, 27 miles from Beaufort. The aggregate cost of the project, if completed, is estimated in 1892 at $71,040.

Work was commenced in 1888 at Cross Stakes Shoal and to June 30, 1891, a cut had been dredged 60 feet wide and 3 to 4 feet deep, 1,015 feet through Cross Stakes Shoal; 60 feet wide and 4 feet deep, 1,840 feet through Turtle Slough Shoal; 40 feet wide and 3 feet deep, 3,628 feet through Goose Creek Shoal; 40 feet wide and 3 to 4 feet deep, 8,546 feet long at Sanders Creek Shoal; and 50 feet wide, 5 feet deep, and 500 feet long at Sally Bell Shoal; aggregating in length 15,529 feet and leaving a length of 5,856 feet still to be dredged.

A contract for doing $7,000 to $9,000 worth of dredging at 25 cents per cubic yard measured in situ, entered into with the Alabama Dredging and Jetty Company December 24, 1890, and approved January 27, 1891, had not been completed June 30, 1891. April 23, 1892, the time for its completion was extended from July 3, 1891, to June 30, 1892.

Under this contract from July 1, 1891, to March 21, 1892, only 170 linear feet of cut were made, all at Sanders Creek Shoal, through the defective construction of a suction dredge improvised by the contractors to replace a clam-shell dredge which they had removed from the work.

March 11, 1892, the suction dredge was replaced by a clam-shell dredge, and on May 7, 1892, the maximum amount of dredging, $9,000 worth, prescribed in the contract was completed.

Work was then continued by the Alabama Dredging and Jetty Company by hired labor at the former contract price by authority from the Chief of Engineers, dated August 3, 1891, to embrace not to exceed $3,000 worth of dredging, which was completed 22d June, 1892.

May 7, 1892, a cut was completed entirely through Sanders Creek Shoal to the width of 40 feet, and June 1, 1892, a cut was completed through Sally Bell Shoal with a minimum width of 50 feet.

Dredging was then commenced on a shoal 2,900 feet in length discovered at the mouth of Broad Creek, 16½ miles from Beaufort, through which a cut 40 feet wide was completed 22d June, 1892.

At the date of this report (June 30, 1892) there is a continuous channel not less than 40 feet wide, through which 3 feet at extreme and 4 feet at ordinary low water can be carried from Beaufort to Swansboro.

Bogue Inlet, at the eastern extremity of this section, has a shifting

channel in which there was 5½ feet at low water on the bar in 1888 and 7 feet inside the bar, the rise and fall of the tide being 3.8 feet. It therefore serves as an outlet from Swansboro for vessels of deeper draft than can navigate Bogue Sound when loaded with lumber and other products of White Oak River and vicinity.

By the census of 1890 the population of Beaufort, at the eastern extremity of this waterway, is 2,007, and at Swansboro, at the western extremity, 233, with no intermediate places of any importance.

By the same census the number of bales of cotton raised in Carteret County, in which this waterway lies, was in 1859, 4; in 1869, 774; in 1879, 1,014, on 2,936 acres; and in 1889, 690 bales, on 2,600 acres.

White Oak River, penetrating at a point opposite Bogue Inlet, 32 miles inland, is the most productive locality on or near the line of this waterway, producing in considerable quantities lumber, naval stores, and agricultural products. Below its mouth and just within the inlet a considerable quantity of its lumber is transferred to outside coastwise vessels which can pass through Bogue Inlet, drawing 7 feet. The other products of White Oak River, as well as the way traffic in Bogue Sound, are carried in a small steamer plying two or three times weekly between Swansboro and Beaufort and in small sharpies, the latter to a great extent continuing past Beaufort and through the Harlowe and Clubfoot Canal to Newbern, which has a width, 3 miles through the canal and for 10,344 feet through the dredged channel in Harlowe Creek, of only 30 feet.

These vessels readily pass through these 5 miles of 30-foot channel in the canal route, and can as easily pass through the 40-foot channel dredged across the shoals in Bogue Sound, none of which exceeds 2.6 miles in length. Moreover, if the width of the dredged channels across the shoals were increased to 100 feet prescribed in the project, the channel would still be too narrow to permit vessels to tack and they would still be limited to sailing through in fair winds or poling through when the wind fails or is adverse.

The present needs of navigation in Bogue Sound seem to be adequately provided for by the channel, nowhere less than 40 feet in width, now completed through all these shoals.

The report of Assistant Engineer W. H. Chadbourn, jr., who diligently exercised the supervision of this work during the fiscal year, is appended hereto.

This waterway is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1891, balance unexpended	$10,967.39
June 30, 1892, amount expended during fiscal year	9,056.29
July 1, 1892, balance unexpended	1,911.10
July 1, 1892, outstanding liabilities	1,862.84
July 1, 1892, balance available	48.26
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	10,048.26
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

REPORT OF ASSISTANT ENGINEER W. H. CHADBOURN, JR.

UNITED STATES ENGINEER OFFICE,
Beaufort, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report on the improvement of the waterway between Beaufort Harbor and New River, North Carolina, for the fiscal year ending June 30, 1892.

Dredging operations have been carried on by the Alabama Dredging and Jetty Company, contractors under an unfinished contract dated December 24, 1890. This contract was partly executed last year and operations discontinued to allow the construction of a special dredge. This new dredge began work October 1, 1891, but was found very defective, and up to November 30, when operations ceased, only 777.57 cubic yards of material had been removed.

March 11, 1892, the clam-shell dredge *Alabama* was put to work and completed the contract. Under the contract 4,310 linear feet of cutting 40 feet wide and 3 to 4 feet deep at dead low water was dredged across Sanders Creek Shoal, removing 8,501.74 cubic yards of material and 500 linear feet of cutting 50 feet wide, 5 to 6 feet deep at low water, from Sally Bell Shoal, removing 2,725.56 cubic yards of material.

Dumpage was placed on the side of the cuts from 35 to 40 feet distant, sometimes on north side and sometimes on south side.

Under a supplemental agreement with the contractors for dredging under the same conditions as under the contract 530 linear feet of cutting 40 feet wide and 3 to 4 feet deep at low water was dredged from Sanders Creek Shoal, removing 1,624.05 cubic yards and completing the cut entirely across this shoal. Also 798 linear feet of cutting 100 feet wide and 5 to 6 feet deep at low water were dredged from Sally Bell Shoal, removing 4,984.15 cubic yards.

A cut 40 feet wide, 2,800 feet long, and 3 to 4 feet deep at low water was dredged across Broad Creek Shoal, removing 5,170.06 cubic yards.

An examination of dredging done in former years showed that in no place had any of the dumpage washed back into the cuts and that the cuts were in fully as good condition as when dredged, and in some places they had scoured out to a greater depth and width.

With the completion of this work there is a good channel everywhere 4 feet deep at ordinary low water and 40 feet wide over the whole distance of this waterway, and it is expected that the commerce will rapidly increase.

The commerce of this waterway is carried on almost entirely in sailboats,* from small size up to boats of 30 tons.

Following is the estimate of the amount that will probably be required to complete the present project:

114,000 cubic yards dredging, at 30 cents	$34,200
Add for superintendence and contingencies	6,840
Total	41,040

The work of the United States employés has been the necessary superintendence and inspection of dredging operations and a survey of Broad Creek Shoal.

The expenses of the year, under my direction, have been:

For purchase and repair of plant	$57.55
For superintendence and surveys	1,864.60
For dredging	8,251.51
Total	10,173.66

(Three hundred and eighty-one dollars and sixty-one cents of extra superintendence expenses incurred on account of the extension of the contract were paid out of amount due to the contractors and are not included in above.)

Dredging operations were carried on under the immediate supervision of Inspector Frank D. Perry, who rendered faithful and efficient service.

Very respectfully, your obedient servant,

W. H. CHADBOURN, JR.,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. Army.

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*The steamer *Nannie B.*, 54.81 tons, runs irregularly over this waterway, but it is expected that she will run more regularly now that she can cross the shoals easily.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$30,400		$30,400	270
Tobacco		$16,000	16,000	17
Rice	4,000	2,000	6,000	110
Grains and forage	3,000	7,500	10,500	550
Vegetables and truck	45,100		45,100	900
Live stock and products	19,000	6,000	25,000	400
Fish, oysters, etc	37,500		37,500	3,213
Naval stores	26,000		26,000	1,150
Lumber and products	118,000		118,000	20,300
Fertilizers	1,200	12,500	13,700	530
Machinery		7,500	7,500	30
General merchandise		158,000	158,000	2,400
Sundries	5,000	4,000	9,000	350
Total	289,200	213,500	502,700	30,240

Gain over last year, $24,500; tons, 900.

Transportation lines established during year, none.

The above statistics are based mainly upon reports of Assistant Engineer W. H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Inland waterway between Beaufort and New River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
August 5, 1886	$10,000	$10,000
August 11, 1888	5,000	15,000
September 19, 1890	15,000	30,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1887	$410.57	$410.57
1888	6,265.94	6,676.51
1889	7,918.55	14,595.06
1890	42.83	14,637.89
1891	4,866.92	19,504.81

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1887	12,250	$200,600
1888		175,800
1889		277,640
1890		418,400
1891	29,332	478,200

L 14.

IMPROVEMENT OF WATERWAY BETWEEN NEW RIVER AND SWANSBORO, NORTH CAROLINA.

Between the mainland and the slender sand bank interposed between the ocean and the sounds along the coast of North Carolina there is, from Swansboro 15 miles to New River, instead of a shallow sound, an expanse of salt marsh from one-eighth of a mile to 1¾ miles wide, through which there is an intricate and tortuous bayou 22 miles in length, constituting the inland waterway from Swansboro to New River.

The tide ebbs and flows in the bayou through four inlets through the sand banks from the ocean, in the channels upon and immediately within whose bars there were, by the Coast Survey chart, in 1888, depths of water as follows: Bogue Inlet, opposite Swansboro, with 5½ feet on the bar and 7 feet inside at low water; Bear Inlet, 3 miles farther west, with 6½ feet on the bar and 7 feet inside; Brown's Inlet, 2¾ miles farther west, "a mere swash," with 3½ feet on the bar and 4 feet inside; and New River Inlet, 8¼ miles farther west, with 4 feet on the bar at low water at the date of this report.

The channels on these bars at the inlets are changeable in depth and position.

At low tide the depth of water in the bayou varies from the foregoing and greater depths near the inlets to not more than 6 inches on the shoals at the "divides" between the inlets where the tide meets and divides.

An examination and survey of this waterway was ordered by section 13 of the river and harbor act of 1888. A preliminary examination or reconnaissance was made and report thereon submitted by Capt. W. H. Bixby, Corps of Engineers, then in charge of the improvement, March 13, 1889, in which the cost of securing a channel through which 3 to 4 feet could be carried at high tide was estimated at $43,000.

By the act of September 19, 1890, the sum of $5,000 was appropriated for this improvement.

In April and May, 1891, a survey was made of all parts of the route "carrying less than 2 feet at low water," embracing the shoals Cow Horn and Standback "and the 5 miles of the route at the New River end," by Mr. W. H. Chadbourn, jr., assistant engineer, by whom the waterway is described as follows:

> This waterway is about 22 miles long, and a greater part of the distance is composed of very crooked and narrow channels through the marshes.
>
> From Swansboro the first 10 miles, passing near Bogue Inlet and directly across Bear Inlet, the channel is from 60 to 1,000 feet wide, carrying from 3 to 10 feet of water at low water everywhere, except one short shoal known as Cow Horn, about 4.4 miles from Swansboro, which has 1.2 feet of water on it.
>
> For the next 5 miles the channel is from 60 to 800 feet wide, average about 150 feet, and has from 3 to 12 feet of water at low water, except at a short shoal known as Standback, midway between Bear and Brown inlets, situated at the meeting of the tides from these inlets, which has about 6 inches of water upon it at low water.
>
> For the remaining 7 miles the route is very crooked and the channel in most places from 12 to 60 feet wide, and carrying from one-half to 3 feet of water at low water, the former depth for about 2 miles of the distance.
>
> The ordinary rise of tide for the first 5 miles is about 2.5 feet; for the next 10 miles from 3.5 to 4 feet, and on the remaining 7 miles from 1 to 2 feet, the former depth at the shoalest parts.
>
> The commerce of this route at present is practically nothing, owing to the difficulties boats experience at the shoals.

Excepting the sum of $617 applied to this survey, no money has been spent upon this waterway for the reasons given in the following corre-

spondence published in House Ex. Doc., No. 26, Fifty-second Congress, first session:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 24, 1891.

SIR: I have the honor to state that in compliance with a requirement of the river and harbor act of August 11, 1888, an examination of the "waterway between New River and Swansboro, N. C.," was made by Capt. W. H. Bixby, Corps of Engineers, who, in report dated March 13, 1889, stated that it was worthy of improvement. This report was transmitted to Congress, and an appropriation of $5,000 for the improvement of the waterway was made in the river and harbor act of September 19, 1890.

A company was incorporated February 13, 1889, by an act of the legislature of the State of North Carolina, under the title of "The Wrightsville and Onslow Navigation Company," and to this company was given exclusive rights to the navigation of the said waterway. This incorporation did not come to the knowledge of this office until after the present available funds had been appropriated by Congress, and under the circumstances work has been restricted to a survey sufficiently detailed to enable the officer in charge to locate the necessary work and estimate its cost, ready for active operations in case future work be ordered.

A copy of the act of the general assembly of North Carolina above referred to is submitted herewith, and it is recommended that it be transmitted to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brigadier-General, Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

AN ACT to incorporate the Wrightsville and Onslow Navigation Company.

The general assembly of North Carolina do enact:

SECTION 1. That for the purpose of navigating by steamboats the waters of the sounds from the point near Fort Fisher, in the county of New Hanover, to the junction of the waters of the sounds with the waters of New River, and from New River to Swansboro, in Onslow County, and also the waters of said New River, B. R. Moore, E. S. Latimer, J. H. Chadbourn, jr., and G. H. Smith, and their associates, successors, and assigns, are hereby constituted a body corporate under the name and style of "The Wrightsville and Onslow Navigation Company," with a capital stock of twenty-five hundred dollars, with power to increase the same to one hundred thousand dollars, which shall have a corporate existence, together with the powers and franchises herein granted in perpetuity as a body politic, and by that name may sue and be sued, plead and be impleaded, in every court in the State of North Carolina, and may have and use a corporate seal, and shall be capable of purchasing, owning, leasing, and conveying estates, real, personal, and mixed, and by acquiring the same by gift or devise for the purpose herein contemplated; and the said company shall have and enjoy all the rights and immunities which other corporate bodies may lawfully exercise, and may make all necessary by-laws and regulations for its government not inconsistent with the constitution and laws of the State or of the United States.

SEC. 2. That the said capital stock of said company may be created by subscription on the part of individuals or of municipal or other corporations in shares of the value of twenty-five dollars each, which subscription may be paid in lands, timber, boats, labor, services, or money, as may be stipulated.

SEC. 3. That books of subscription may be opened by the corporators herein named at such times and places and under such rules and regulations as a majority of them shall direct.

SEC. 4. That when the sum of fifteen hundred dollars shall have been subscribed to the capital stock of said company, a general meeting of the stockholders shall be held, after due notice, and such general meeting, a majority of the stockholders being present either in person or by proxy, shall elect a board of directors, to consist of such a number, not less than three, as the stockholders shall determine; and said directors shall immediately thereafter elect one of their number president, and such other officers as the by-laws of said company shall prescribe, and may do and perform all other acts necessary to the complete organization of said company, and to carry into effect the object of this charter.

SEC. 5. That whenever any land shall be required for the construction of ware-

houses, landings, or for canals, and for any cause the same can not be purchased from the owner, the same may be taken by the directors at a valuation to be ascertained as follows: The Wrightsville and Onslow Navigation Company, by its president, shall select two disinterested freeholders of the county in which the said land lies, and the owner of said land shall likewise select two freeholders of the same county, who shall ascertain the value of said land, they first deducting the enhanced value of adjoining lands which may belong to the owner of said lands by the establishment of such steamboat landing or by the opening up for navigation of such canal, and by adding any particular loss or damage; and if these four assessors can not agree, they shall call in a fifth such freeholder, and upon the payment, or tender of payment, of the amount so assessed by the president, the title of the land so appraised shall thereby vest in the said corporation: *Provided*, That either party may appeal from the decision of said appraisers to the superior court of the county wherein the land lies upon the question of the amount assessed: *And provided further*, That no more than one acre of land at any one landing shall be liable to be so condemned for the purposes of a warehouse and landing.

SEC. 6. That the president and directors shall have power at any time to borrow money upon the lands of the company and to secure the same by mortgage or other legal assurance.

SEC. 7. That the said company shall have the exclusive right to convey and transport freight and passengers over and along the waters of said sounds; that is to say, from what is commonly called the head of the sound, in New Hanover, northwardly and return to the waters of New River, in Onslow County, and thence on to Swansboro by steamboats and sailing vessels, and at such rates as said company shall prescribe: *Provided*, That said company shall open a connection, whenever necessary, between the waters of said sounds by canal sufficient to carry into effect the objects of this charter.

SEC. 8. That said company shall have the power and authority to construct and open a ship canal connecting the waters of Wrightsville Sound, or Masonboro Sound, with the waters of the Cape Fear River, and to this end may use the creeks and water courses at all intermediate points, and may seize and cause to be assessed all lands necessary therefor, under the restrictions and provisions contained in section five of this chapter, and shall have power to fix the tariff of tolls for all vessels that said company may allow to pass through the same, and to demand and collect said tolls; and the said company shall have the exclusive right for the period of ten years, from and after the ratification of this act, to construct the canal aforesaid.

SEC. 9. That this act shall be in force from and after its ratification.

Ratified the thirteenth day of February, anno Domini one thousand eight hundred and eighty-nine.

The total final cost of securing a channel 40 feet wide and 3 to 4 feet deep at high water was estimated in 1889 at $43,000.

It is to be observed that vessels passing on the open ocean from New River to Swansboro parallel with this waterway and only one-half mile from it can find shelter within the four inlets above described at intervals of only 2¾ to 8 miles.

Swansboro, the only village on this route, has a population, by the census of 1890, of 233.

Onslow County, within which this route lies, has an area of 640 square miles and a population by the census of 1890, of 10,303.

By the same census the cotton produced in the county in 1859 was 336 bales, in 1869, 881 bales, in 1879, 2,841 bales on 6,658 acres, and in 1889, 1,720 bales on 6,127 acres.

This waterway is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1891, balance unexpended	$4,516.00
June 30, 1892, amount expended during fiscal year	133.75
July 1, 1892, balance unexpended	**4,382.25**

Amount (estimated) required for completion of existing project $38,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894.*
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Inland waterway between New River and Swansboro.

Appropriated September 19, 1890	$5,000.00
Expended fiscal year ending June 30, 1891	509.76
Freight transported during fiscal year ending June 30, 1891 (3,000 tons) ..	20,000.00

L 15.

IMPROVEMENT OF NEW RIVER, NORTH CAROLINA.

New River communicates with the ocean through New River Inlet 40 miles southwesterly from Beaufort Harbor and about 70 miles northeasterly from the mouth of the Cape Fear River.

From the ocean 21 miles inland to the narrows its width is from about 2,000 feet to about 2½ miles, at the narrows it is about 1,000 feet, and above Jacksonville, 23 miles from the mouth, it becomes a comparatively narrow river.

The channel across the bar is changeable both in depth and position, but has at the date of this report, as in 1888, a minimum depth of 4 feet at mean low water.

Just within the inlet there are extensive marshes and beds of oyster rock, extending to a point about 3½ miles from the ocean bar, through which, before improvement by the United States, there was a long and tortuous channel about 50 feet wide and 3 feet deep at low water. From the marshes navigation of the river was unimpeded for vessels of 5 feet draft to a point 3 miles above Jacksonville.

Between 1855 and 1861 the improvement of the channel through the marshes is reported to have been commenced by a stock company incorporated under the laws of the State of North Carolina, by the application of $10,000 appropriated by the State and of $20,000 raised by subscription.

The project, matured in 1885, for improvement by the United States, and not since modified, is to dredge two straight channels 150 feet wide and 4 feet deep at mean low water (one, 1,210 feet long, through Wrights Island, commencing about one-half mile above the bar, the other, 5,710 feet long, through Cedar Bush Marsh commencing about 1⅛ miles above the bar), at an estimated cost of $40,000.

Ten thousand dollars having become available from two appropriations, work was commenced in 1886, when 32,824 cubic yards of shells and mud were dredged from Cedar Bush Marsh, making a straight channel 5,800 feet long through it, 40 feet wide at bottom and 4 feet deep, excepting at the lower end where its depth was 3.1 feet. By the removal of 2,707 cubic yards of turf and mud by hand a cut 30 feet wide and not exceeding 6 inches deep at low water, was made 1,200 feet through Wrights' Island, to induce its further deepening by scour.

*See House Ex. Doc. No. 26, Fifty-second Congress, first session, regarding control of this waterway by Wrightsville and Onslow Navigation Company.

November 3, 1887, to March 21, 1888, with a further appropriation of $10,000, made by the act of August 5, 1886, by the removal of 24,861 cubic yards the cut at Wrights Island, 1,210 feet long, was dredged to the variable widths of 90, 100, and 120 feet and average depth of 4 feet at mean low water, and by the removal of 4,421 cubic yards the lower part of the cut at Cedar Bush Marsh was widened and deepened.

Since March 21, 1888, work has not been resumed.

The act of August 11, 1888, appropriated $3,000, and that of September 19, 1890, $5,000, and contract with the Alabama Dredging and Jetty Company was entered into December 24, 1890, and approved January 27, 1891, to do $5,500 to $6,500 worth of dredging at 39 cents per cubic yard, measured *in situ*, in increasing the width of the cut at Cedar Bush Marsh to 100 feet and its depth to 5 feet, the work to be commenced on or before December 3, 1891, and to be completed before April 23, 1892, on which date the contract was extended to June 30, 1892. The contractors have not yet commenced work.

At the date of this report, June 30, 1892, the cut through Wrights Island has scoured to the depth of 15 feet nearly its entire length, but the cut at Cedar Bush Marsh has shoaled at each end and can now be used only by vessels of very light draft.

All the material dredged from these cuts was dumped immediately alongside them, and in the cut through Cedar Bush Marsh, in 1886, the contractor had to resort to sheet-piling to keep it from running back into the channel.

In the Coast Survey Bulletin No. 10, issued January 30, 1889, it is reported that the natural advantages of New River for oyster culture are "superior to those of any locality in the country;" that no better quality of oysters can be found anywhere in the world; that the beds extend from the marshes at the mouth of the river to Sneeds Ferry, about 3½ miles above, besides others in Chadwicks and Howards bays adjoining it, and that in fact "the whole river bed is covered more or less with oysters."

The Onslow and East Carolina Railroad, 50 miles in length, which was opened in February, 1891, from Wilmington to Jacksonville, affords quick transportation for the product of these beds and an outlet for lumber and farm products from the vicinity of New River, and has much reduced the traffic that would be benefited by the improvement of the channel at its mouth.

The country traversed by this road is largely wooded and its soil very sandy and unproductive.

The area of Onslow County, in which New River is situated, is 640 square miles. By the United States census its population was, in 1880, 9,829, and in 1890, 10,303; the population of Jacksonville village, 170; and the cotton produced in 1859, 336 bales, in 1869, 881 bales, in 1879, 2,841 bales on 6,658 acres, and in 1889, 1,720 bales on 6,127 acres.

The river is navigated by the steamer *Louise*, of 27.3 tons, the steamer *Blanche*, of 47.43 tons, by one or two other steamers owned and operated by oyster companies, and by many small sailboats, but none of the steamers and only a few of the sailboats navigate the channel to be improved.

This river is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1891, balance unexpended		$8,343.04
June 30, 1892, amount expended during fiscal year		121.19
July 1, 1892, balance unexpended		8,221.85
July 1, 1892, outstanding liabilities	$2.00	
July 1, 1892, amount covered by uncompleted contracts	6,500.00	
		6,502.00
July 1, 1892, balance available		1,719.85
Amount appropriated by act approved July 13, 1892		5,000.00
Amount available for fiscal year ending June 30, 1893		6,719.85
Amount (estimated) required for completion of existing project		7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		*7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$156,500		$156,500	1,428
Tobacco		$10,000	10,000	22
Rice	800		800	20
Grains and forage	4,800	5,100	9,900	564
Vegetables and truck	125,500		125,500	4,445
Live stock and products	61,000		61,000	400
Fish, oysters, etc	100,000		100,000	2,531
Naval stores	60,000		60,000	2,232
Lumber and products	98,000		98,000	9,255
Coal and minerals		1,850	1,850	266
Fertilizers		2,250	2,250	75
Machinery		10,000	10,000	100
General merchandise		257,700	257,700	2,000
Sundries	16,150	1,350	17,500	500
Total	622,750	288,250	911,000	23,838

Gain over last year, $167,650.

Transportation lines established during year: One, a daily line from Jacksonville to Marines.

The above statistics are based mainly upon reports of Assistant Engineer W. H. Chadbourn, jr., made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

New River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
July 4, 1836, to July 7, 1838		$50,000
August 2, 1882	$5,000	5,000
July 4, 1884	5,000	10,000
August 5, 1886	10,000	20,000
August 11, 1888	3,000	23,000
September 19, 1890	5,000	28,000

*If it is determined to complete project, which, in the opinion of the District Engineer, is of very doubtful expediency, $7,000 is a suitable amount for application to the work in one year, but the number and size of vessels now navigating the river, or that will probably navigate it in future, do not justify the statement that $7,000 can be profitably expended for its improvement.

New River, North Carolina—Continued.

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1837 to 1839	....	*$48, 833. 54
1886	$9, 810. 24	9, 810. 24
1887	181. 80	9, 992. 04
1888	8, 191. 37	18, 183. 41
1889	349. 08	18, 532. 49
1890	655. 69	19, 188. 18
1891	499. 85	19, 688. 03

* Balance of $1, 166. 46 turned over to surplus fund.

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1883	5, 000	$290, 000
1887	....	696, 000
1889	....	705, 950
1890	....	731, 550
1891	17, 359	743, 350

L 16.

IMPROVEMENT OF NORTH EAST (CAPE FEAR) RIVER, NORTH CAROLINA.

This tributary approximates in size to the main Cape Fear River, which it joins from the left bank immediately above Wilmington and 30 miles from the ocean. From the confluence up 50 miles it is tidal, with a least depth of 6 feet at lowest stages of tide and water, and easily navigable by small steamers towing two flats alongside. For the next 40 miles, from near Bannerman's Bridge to near Hallsville, it is reported to have a depth of about 3 feet at ordinary stages, and to flow with gentle slope between banks of a moderate height. For the next 13 miles, up to Kornegay's Bridge, 103 miles above the confluence, the stream is narrower, more crooked, and its banks lower. It is quite tortuous, being 130 miles in length between points 70 miles apart in an air line. Below Kornegay's Bridge there are reported to be at intervals of 6 to 10 miles some eleven settlements, at most of which there are said to be stores, turpentine stills, cotton gins, grist and saw mills. The river below Kornegay's Bridge is crossed by seven county bridges and one railroad bridge. A draw is being placed in the latter, but three of the county bridges are without draws.

The river is subject to freshets, having a recorded extreme rise of 5.8 feet at Kornegay's Bridge, 7.7 feet at Sarecta, 13.4 feet at Hallsville, 13.8 feet at Chinquapin, 16.3 feet at Deep Bottom Bridge, 16½ feet at Croom's Bridge, 6.6 feet at Bannerman's Bridge, and 6 feet at Castle Hayne, 27 miles above the confluence.

When its improvement was commenced by the United States in 1890, it was easily navigable up 48 miles to Bannerman's Bridge, above which it was everywhere "badly obstructed by snags and by overhanging, leaning, and fallen trees, so as to completely block navigation at all ordinary stages of water."

The project of 1889, not since modified, is "to thoroughly clear a channel of good width and natural depth for small light-draft steamers up to Hallsville and for pole boats up to Kornegays Bridge" by the removal of snags, stumps, fallen, leaning, and overhanging trees at an estimated cost of $30,000.

With the sum of $5,000 appropriated by the act of September 19, 1890, the improvement was commenced at Bannermans Bridge, 48 miles above the confluence, in January, 1891, and continued to April 24, 1891, when the plant returned to Wilmington. No work was thereafter done to June 30, 1891, at which date the channel to a width of 40 feet and to its natural depth, and the banks had been roughly cleared "of the worst obstructions to a high-water navigation" from Bannermans Bridge up 31½ miles to Chinquapin, at a total expense of $3,173.60.

During the fiscal year ending June 30, 1892, 2 trees, 3 stumps, 20 logs, 8 snags, and parts of an old steamboat, scow, and boiler which were troublesome to navigation were removed from the channel above Hilton Bridge, 2½ miles above Wilmington. This work was done in September and October, 1891, since which date no work has been done upon the river.

During the year a daily record has been kept of water gauges at the seven following points: Kornegays Bridge, Hallsville, Chinquapin, Sarecta, Deep Bottom Bridge, Crooms Bridge, and Castle Hayne.

At the date of this report, June 30, 1892, the river is badly obstructed by logs and snags above Bannermans Bridge.

The two counties of Duplin and Pender, through the central portion of which the improved part of this river flows, have a total area of 1,470 square miles, and had by the United States census a total population in 1880 of 31,241, and in 1890 of 31,204.

By the same census there were raised in these two counties in 1879, 5,334 bales of cotton on 11,117 acres, and in 1889, 3,380 bales on 12,306 acres.

These counties are said to be very favorable in climate and soil for truck farming, but products of that nature require quick transportation to market by rail.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1891, balance unexpended	$1,866.40
June 30, 1892, amount expended during fiscal year	674.61
July 1, 1892, balance unexpended	1,191.79
July 1, 1892, outstanding liabilities	35.50
July 1, 1892, balance available	1,156.29
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	6,156.29
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$8,900		$8,900	170
Tobacco		$750	750	2
Rice	3,000		3,000	66
Grains and forage	4,490	2,050	6,540	254
Vegetables and truck	1,300		1,300	45
Live stock and products	4,020		4,020	25
Naval stores	129,000		129,000	6,640
Lumber and products	60,700		60,700	22,170
Fertilizers		600	600	50
General merchandise	1,000	61,200	62,200	868
Sundries		300	300	5
Total	212,410	64,900	277,310	30,295

Gain over last year: $7,310.

The tonnage decrease is due to the falling off of naval stores exported.

The above statistics are based mainly upon reports of Assistant Engineer E. D. Thompson, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Northeast (Cape Fear) River.

Appropriated September 19, 1890	$5,000.00
Expended fiscal year ending June 30, 1891	3,173.60
Freight transported during fiscal year ending June 30, 1891 (40,596 tons)	270,000.00

L 17.

IMPROVEMENT OF BLACK RIVER, NORTH CAROLINA.

The river is a tributary to the Cape Fear River, which it joins from the left bank 14½ miles above Wilmington, and 42½ miles from the ocean.

From its confluence up 15 miles it is about 300 feet wide; thence 15 miles farther to Goff Narrows, 6 miles above Point Caswell, it is 150 feet wide. Through Goff Narrows, 2 miles in length, the channel is very crooked and about 75 feet wide, fully half of the water spreading out through a cypress swamp. From Goff Narrows 2 miles to Haws Narrows its width is about 150 feet between firm banks. Through Haws Narrows, 4 miles in length, its water again spreads through a cypress swamp, the channel being very crooked and only about 35 feet wide; thence 10 miles to South River (or Beatty) Narrows, 24 miles above Point Caswell, its width is about 450 feet between high, firm banks. Through South River Narrows, 4 miles in length, the channel is very crooked and about 40 feet wide, a large part of the water again flowing through a cypress swamp. From South River Narrows up 34 miles to Lisbon its width varies from 35 to 300 feet.

Its depth at low-water summer stage is nowhere less than 4 feet from the confluence to Point Caswell, nor less than 2½ feet anywhere; thence 10 miles to Haws Narrows through which there is a series of short shoals upon which the least depth is 18 inches. From Haws Narrows 10 to 12 feet can be carried to South River Narrows in which there are two shoals each about 50 feet long with a minimum depth of

3 feet. From South River Narrows to Clear Run the depth is not less than 3 feet, and from Clear Run 10 miles to Lisbon, it is 18 inches.

The shoals are all said to be accumulations of sand caused by logs which sink while being floated or driven in unrafted masses down the river.

The bed of the river is very coarse sand throughout.

Below Lisbon the river flows for about two-thirds of its length through a pine forest and for the other third through swamps timbered with cypress, gum, and maple.

There are 6 steam saw mills and 2 shingle mills on its banks, 54 stores receiving freight from the river and 18 turpentine distilleries below Lisbon shipping their products upon it. Its branches above Lisbon, upon which there are 6 or 7 turpentine stills, aggregate about 100 miles in length, reach to an air-line distance of about 25 miles and from it are navigated by rafts bringing down resin and turpentine.

In freshets during the year 1890 when gauge records were kept the recorded extreme rise was 10.3 feet at Clear Run, 8.2 feet at Hampton Landing, 5 feet at Mill Creek, and 4.8 feet at Point Caswell, these points being respectively, 76, 58, 41, and 24 miles above the confluence with the Cape Fear River.

There is said to be at low stages a lunar tide of about 2 feet at Point Caswell and of about 6 inches at the lower end of Haws Narrows, 75 miles from the ocean, above which it is imperceptible.

The banks average about 8 feet in height above the summer stage, but attain 60 feet just below Clear Run, and in high freshets are overflowed almost the entire length of the river, the water spreading about one-half mile on either side.

During the summer the water remains nearly constant at low-water stage. At a variable date between August and September the river generally rises 5 to 8 feet in one week, thus reaching suddenly its winter high-water stage, and remains up till about April. After April, and before July, it falls gradually to its summer low-water stage.

By an act of the General Assembly of North Carolina, ratified February 24, 1877 (Annual Report, Chief of Engineers, 1885, pages 1153 and 1154), "The Black River Navigation Company" was incorporated "to clear out, improve, and render fit for steamboat navigation the waters of Big Coharie and Black rivers above the point on Black River at which such navigation is now practicable," with "the sole and exclusive right and privilege to navigate said rivers with steamboats from Point Caswell in the county of Pender to all points up said Black River and Big Coharie, for the period of fifty years." This act was repealed by the following:

AN ACT to repeal chapter 37, laws of 1876 and 1877, incorporating the Black River Navigation Company.

The General Assembly of North Carolina do enact:

SECTION 1. That chapter thirty-seven of the laws of eighteen hundred and seventy-six and seventy-seven be, and the same is hereby, repealed, and every part thereof.

SEC. 2. That this act shall be in force from and after its ratification.

Ratified the 7th day of March, A. D. 1887.

Up to 1882 this company removed enough snags from the channel and leaning trees from the banks to enable a steamer drawing 12 inches to navigate the river to Lisbon once a week eight or nine months annually.

When the United States commenced its improvement in 1887 the channel was moderately well cleared up 24 miles to Point Caswell, but above that point 62 miles, to near Lisbon, was only roughly cleared,

being especially obstructed at the bends by leaning and overhanging trees, and was navigated by a steamer of 2½ feet draft once or twice per week all the year to Point Caswell, and nine months annually to Clear Run, about 8 miles below Lisbon.

In 1885 the cost of clearing the banks of overhanging trees and the channel of logs and snags to the depth of 4 feet at low water 24 miles, to Point Caswell, was estimated at $6,500; of clearing the banks of overhanging trees and the channel of logs and snags for a draft of 2½ feet during six to ten months annually from Point Caswell to Lisbon was estimated at $12,000, and if put in thorough order by dredging through shoals and by dredging or diking the so-called narrows (Annual Report Chief of Engineers, 1885, page 1149), the improvement above Point Caswell was estimated to cost in addition $15,000; total, $33,500.

The approved project of 1885 (Annual Report, page 1149), not since modified, is to apply at least $10,000 to removing "logs, snags, and overhanging trees from the bed and banks of the river", and rounding off "a few of the extra sharp bends" from its confluence with the Cape Fear River up 86 miles to Lisbon.

With $3,000 appropriated by the act of August 5, 1886, work was commenced in October, 1887, and continued to January 31, 1888, during which time there were removed from the channel 275 logs, 163 stumps, and 9¾ cords of snags, and from the banks 472 overhanging trees, 98¾ cords of brush, besides trimming 40 trees. No further appropriation has been made and no work done since January 31, 1888.

At the date of this report, June 30, 1892, from the confluence up 24 miles to Point Caswell the river is in excellent condition, excepting within the upper 6 miles, where three trees in the channel and a few leaning trees on the banks badly obstruct it. From Point Caswell to Haws Narrows navigation is impeded only by about 6 trees in the channel and by about 12 leaning trees from the banks, which latter are difficult to pass. Through Haws Narrows there are logs in the bed of the river which have caused the formation of the shoals, but no snags. From Haws Narrows to South River Narrows there are no obstructions in the channel or on the banks. South River Narrows is obstructed by a mass of logs in the bed of the river, through which there is a tortuous 3-foot channel, and by many overhanging trees. From South River Narrows up 34 miles to Lisbon the channel is badly obstructed by snags, logs, stumps, and overhanging trees.

The estimated further approximate cost of removing logs, stumps, and overhanging trees from the bed and banks of the entire river and of rounding off some of its sharpest points at bends is estimated (Annual Report Chief of Engineers, 1888, page 892) at $11,000, making, with the $3,000 already applied, a total cost of clearing the river of snags, logs, stumps, and overhanging trees of $14,000 instead of $18,500 as given in the first two items of the foregoing estimate of 1885.

The other item above of $15,000 for dredging and diking is not understood to be embraced in the approved project.

The Cape Fear and Yadkin Valley Railroad, put in operation February 17, 1890, with one terminus at Wilmington, N. C., runs nearly parallel with, and nowhere more than 3½ miles from, that section of the river under improvement.

There are five county bridges and one railroad bridge over the river between Point Caswell and Lisbon, all of which, it is reported, will need to be provided with draws of at least 25 feet clear width if the river is to be much navigated by steamers.

The steamer *W. T. Daggett*, of 50.57 net tons, makes two trips weekly without interruption throughout the year from Wilmington to Point Caswell, bringing down naval stores and a little cotton, and taking up general merchandise, household supplies, and fertilizers, and carries about 60 passengers per week each way.

The steamer *Lisbon*, of 66.94 net tons, makes two trips weekly during nine months of the year from Wilmington to Clear Run, and during the other three months to Haws Narrows, bringing down naval stores, lumber, and shingles, and carrying up general merchandise, household supplies, and fertilizers. This steamer always brings down a full cargo, and also tows a lighter to Clear Run each trip, which drifts down loaded with about 400 barrels of resin.

The Black River flows between the Cape Fear River and its other tributary, the Northeast Cape Fear River, at a distance of 6 to 17 miles from the former on the west and 13 to 30 miles from the latter on the east.

South River, joining Black River about 20 miles above Point Caswell, is at the confluence as deep as Black River, very narrow and crooked and much choked with snags and overhanging trees in its lower 20 miles, above which it is said to be broad and clear of obstructions. It is navigated to a point about 65 miles in an air line from its confluence by rafts carrying naval stores.

The river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1891, balance unexpended	$5.93
June 30, 1892, amount expended during fiscal year	5.93
Amount appropriated by act approved July 13, 1892	10,000.00

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$240,000		$240,000	1,500
Tobacco		$5,000	5,000	10
Rice	1,000	10,200	11,200	258
Grains and forage	4,200	18,500	22,700	668
Vegetables and truck	5,225		5,225	277
Live stock and products	48,825	32,000	80,825	450
Fish, oysters, etc	500	2,700	3,200	28
Naval stores	223,000		223,000	20,325
Lumber and products	134,400		134,400	53,200
Fertilizers		17,500	17,500	700
Machinery		50,400	50,400	150
General merchandise		122,450	122,450	1,363
Sundries	3,000	5,150	8,150	500
Total	660,150	263,900	924,050	79,429

Decrease over last year: $21,464; increase in tonnage, 18,118.

Transportation lines established during the year: None.

The above statistics are based mainly upon reports of Assistant Engineer E. D. Thompson, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Black River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
August 5, 1886	$3,000	$3,000

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1887	$42.70	$42.70
1888	2,224.61	2,267.31
1889	109.93	2,377.24
1890	519.61	2,896.85
1891	100.55	2,997.40

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1886	48,650	$750,000
1887	....	1,020,000
1888	....	1,220,296
1889	....	1,181,380
1890	....	1,181,945
1891	61,311	945,514

L 18.

IMPROVEMENT OF CAPE FEAR RIVER ABOVE WILMINGTON, NORTH CAROLINA.

The river above Wilmington is 115 miles in length to Fayetteville, 4 miles above which place and 149 miles from the ocean bar is the head of navigation, at low stages, from tide water. Above the 149 miles the river is susceptible of improvement only for slack-water navigation, for which purpose the State of North Carolina is said to have spent years ago, unsuccessfully, the sum of $350,000.

The part of the river under improvement extends only up to Fayetteville.

It flows through the flat sandy belt of North Carolina, timbered with pine, intersected with cypress swamps, sparsely populated, and producing chiefly naval stores, lumber, shingles, and cotton.

Its width at Point Peter, immediately above the confluence of the Northeast Branch, is 340 feet; 12 miles above it is 760 feet; 25 miles above Wilmington it is narrowest, 120 feet, above which point its width ranges from 150 to 270 feet, being 270 feet at Elizabethtown and 200 to 250 feet at Fayetteville.

Its banks are from 15 to 40 feet high from Fayetteville down 66 miles to Hungry Neck, and are overflowed in the higher freshets; thence 49 miles to Wilmington, except occasional bluffs of sand or sandy marl,

the country is low, much of it swampy, and some of it adapted to rice culture.

Rising in the hilly country near the Blue Ridge and north boundary of the State, it is subject to sudden and frequent freshets, causing a recorded extreme rise of 34.5 feet at Elizabethtown and 52 feet at Fayetteville, where the rise is said to be occasionally as great as 62 feet.

The tidal range is 2.5 feet at Wilmington, and tides are perceptible to Whitehall 54 miles farther.

The bed is of sand, except a small extent of clay at Thames Shoal, 12¼ miles below Fayetteville.

For many years the Cape Fear Navigation Company, chartered in 1796, exacted tolls of steamers plying between Wilmington and Fayetteville, which they were authorized to collect by the original act of incorporation and subsequent amendment. The company maintained "during the low water a scow with the necessary appliances to remove logs and cut down and trim overhanging trees." Pursuant to the river and harbor act of March 3, 1881, "$10,000 therein appropriated were paid to the company for a deed extinguishing the right to take tolls or make charges for the navigation of the portion of the river between Wilmington and Fayetteville.

The foregoing deed having been approved by the Attorney-General, the improvement of the river was commenced by the United States (at Indian Wells Landing 37 miles above Wilmington) June 10, 1882. At that time from Wilmington 49 miles up to Hungry Neck the depth of water was always ample and navigation uninterrupted by shoals; thence 66 miles to Fayetteville there were many shoals on which there was not more than 12 to 14 inches of water during the low-water season; and for the 78 miles above Indian Wells Landing the channel was badly obstructed by sunken logs, snags, and overhanging trees.

The project of 1881, under which the foregoing work was commenced, embraced—

The removal of snags and logs, the clearing away of overhanging trees on the banks, a small amount of dredging, and the construction of jetties or dikes, at first experimentally.

The total estimated cost of the work proposed was $55,755, which, however, was only for the part of the work that will be required for the entire portion of the river in need of improvement. (Annual Report Chief of Engineers, 1881, page 164.)

In this report the depth to which the channel was to be cleared and to which it was to be deepened over the shoals is not specified.

June 30, 1885, "a thoroughly cleared and thoroughly contracted channel of 4 foot depth from Wilmington to Elizabethtown, and 3-foot depth from Elizabethtown to Fayetteville at all stages of water," were estimated to require an expenditure subsequent to that date of $201,000, making, with the $59,013.83 expended to that date, the total final cost of the project as estimated in 1885, $260,013.83. (See Annual Report 1885, pages 1086, 170, and 171, in which it is stated that the foregoing depths are "all that the original project seems to suggest and also all that the limited water supply of the river will allow.")

Of the $59,013.83 expended to June 30, 1885, $10,000 had been paid to the Cape Fear Navigation Company.

The jetties built to that date were chiefly of brush, logs, or planks.

In the Annual Report of 1886, page 996, it is stated by Capt. W. H. Bixby, Corps of Engineers, then in charge of the improvement—

The violence of the freshets has proved too much for brush, log, or ordinary

plank jetties, and in my opinion low stone jetties will prove the most economical in the end. The new estimates for the total cost of the work, $472,700, are as follows:

For clearing away obstructions:	
18,000 snags, at $1	$18,000
5,000 logs, at $2	10,000
2,500 stumps, at $3	7,500
3,000 cubic yards of rock, at $3	9,000
84,000 linear feet of rock jetties, at $3.50	294,000
Contingencies (10 per cent)	34,600
Superintendence (10 per cent)	34,600
Total required	*407,700
Already spent upon this work	65,000
Total	*472,700

The project of 1881, for the improvement of this river as matured in 1885 and 1886, is to secure "at all times of the year" a depth of 4 feet from Wilmington 73 miles to Elizabethtown, and of 3 feet thence 42 miles to Fayettville, by the removal of snags, logs, stumps, and rock, and of overhanging trees from the banks, by the building of 84,000 linear feet of rock jetties and by a small amount of dredging, at an estimated cost subsequent to that date of $407,700, and, including the previous expenditure, at a total estimated final cost of $472,700.

During the ten years that the improvement has been in progress it is reported by the assistant engineer formerly in charge that from June 10, 1882, to June 30, 1892, 33,144 snags, logs, stumps, and trees have been removed from the channel and banks, and 2,837 linear feet of jetties have been built of logs and sheet piles, 2,354 feet of rocks, and 620 feet of brush and stone, aggregating 5,811 linear feet of jetties.

During the fiscal year ending June 30, 1892, 793 feet of jetties were built of stone upon brush matresses, of which 183 linear feet were built upon McRae Shoal, 5 miles below Fayetteville, and 610 feet at Thames Shoal, 7½ miles farther down.

From May 23 to 29, 1892, a survey was made of the shoal at Elizabethtown embracing 2,600 located soundings. June 16 to 30 the work of building stone jetties upon brush mattresses at this shoal was in progress.

During the fiscal year ending June 30, 1892, the aggregate length of jetties built upon these three shoals was 793 linear feet, and during the same period 228 snags, logs, stumps, and trees were removed from the channel and 46 trees and 23 cords of brush from the banks, the details of which work will be found in the appended report of Mr. E. D. Thompson, the efficient assistant engineer in immediate charge of the work.

The comparatively recent opening of stone quarries at Mount Airy and Sanford, N. C., on the line of the Cape Fear and Yadkin Valley Railroad, constructed through Fayetteville within a few years, permits stone suitable for jetties to be delivered at the latter point at $1.34 per ton of 2,240 pounds, the lowest competitive bid recently received, and materially cheaper than it has been possible hitherto to secure it for jetties.

This railroad connecting Fayetteville and Wilmington has also materially reduced the amount of traffic upon the river and caused the number of steamers plying regularly upon it between those two places to be reduced from three to two, making an aggregate of four round

* Incorrectly added in the text as $415,200 and $480,200.

trips per week, one with a net tonnage of 140 and the other of 156 tons.

At the date of this report, June 30, 1892, the condition of the river is approximately as follows:

From Wilmington, 14 miles to the mouth of Black River, the channel and banks are unobstructed; thence to Fayetteville the navigation of the river is not seriously impeded by snags or leaning trees, except at Little Sugar Loaf Shoal, 7 miles below, and at McDowell's Barn Shoal, about 3 miles above Elizabethtown, at each of which points for a distance of about 150 feet it is quite badly obstructed by masses of snags in the channel, and also at occasional points where the caving of the banks has carried trees into the river.

From Wilmington up 46 miles to Kellys Cove 4 feet can be carried at lowest stages; thence 27 miles to Elizabethtown there are four shoals, namely, Little Sugar Loaf, 150 feet long, Waddell Ferry, 60 feet long, and Browns Reach and Cypress, each about 90 feet long, aggregating about 400 feet, upon which pilots report the least depth at lowest stages, about every third year, to be about 2 feet, but upon which there are 3 feet at low summer stages for about two continuous years.

From Elizabethtown, 42 miles, to Fayetteville there are numerous short shoals, aggregating about 12 miles in length, upon which pilots report the least depth at exceptionally low seasons to be 18 to 20 inches, and at ordinary low seasons 30 inches to 3 feet.

The part of this river from Wilmington to Fayetteville and of its two tributaries, the Black and Northeast Cape Fear rivers, under improvement by the United States at a total estimated cost of $524,200, are almost wholly in the five counties of Duplin, Pender, Sampson, Cumberland, and Bladen. These five counties have an aggregate area of 4,110 square miles, and by the United States census had a population in 1880 of 94,129, and in 1890 of 100,384; and produced in 1880, 16,213 bales of cotton on 37,291 acres, and in 1890, 16,149 bales on 55,964 acres.

The river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1891, balance unexpended	$10, 070. 92
June 30, 1892, amount expended during fiscal year	5, 520. 93
July 1, 1892, balance unexpended	4, 549. 99
July 1, 1892, outstanding liabilities	530. 30
July 1, 1892, balance available	4, 019. 69
Amount appropriated by act approved July 13, 1892	15, 000. 00
Amount available for fiscal year ending June 30, 1893	19, 019. 69
Amount (estimated) required for completion of existing project	354, 250. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894	30, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report on the improvement of

Cape Fear River, North Carolina, above Wilmington, for the fiscal year ending June 30, 1892:

Up to July 1, 1891, upward of 5,000 linear feet of jetties had been built on the following shoals, viz:

	Miles above Wilmington.
Fayetteville	115
McCarter Cross	114
Old jetties	112½
McRae	110½
Smiths Cross	107
Thames	102
Morehead	78
Elizabethtown	73
Cypress	63½

The river had been snagged so as to give a moderately good 4-foot channel 100 feet wide during the entire year from Wilmington, 46 miles, to Kelley Cove, thence a similar 3-foot channel 27 miles farther to Elizabethtown, thence a 2-foot channel 80 feet wide 42 miles farther to Fayetteville.

Stone had been quarried and deposited along the bank for use in jetties as follows:

	Yards.
McCarter Cross	100
McRae	160
Thames	600
Purdies to Melvin	300
McDowell Barn	250
Elizabethtown	250
Browns Landing	200
Total	1,860

All work was in progress July 1, 1891.

From July 1 to October 13, 1891, there were built at Thames Shoal 5 jetties, aggregating 610 feet in length; McRae's Shoal, 2 jetties, aggregating 183 feet; total, 793.

During the same period 366 cords of brush and 10 cords of stakes were cut and used with 659 yards of rock in construction of jetties.

From 51 to 64 miles, 65 to 66 miles, and 68 to 99 miles above Wilmington, total 46 miles, there were taken from the river channels 64 trees, 57 stumps, 70 logs, and 37 large snags; and 46 trees were cut down and hauled back and 23 cords small brush removed from the banks.

On account of high water field work was suspended October 13, and the plant laid up at Wilmington until the following season.

May 23 to 29, 1892, a careful survey was made of Elizabethtown Shoal. This survey shows that quite a change has taken place in the channel since the examination of 1885, so that a treatment entirely different from that proposed in 1885 is now needed. A new project was accordingly submitted; after its approval a working party was put in the field June 11, and up to June 30 the following work had been done:

Jetties built: None completed.

Jetties removed	linear feet	105
Rocks used	cubic yards	75
Brush cut and used	cords	127

Gauges were maintained during the year at Fayetteville and Elizabethtown.

Past works of construction on this river have been based on the principle of using United States labor for obtaining all supplies, such as brush and rock.

After looking over the situation carefully it was decided this spring to abandon the expensive and cumbersome method of quarrying rock by United States labor and buy, as needed, under sealed proposals. The following proposals were received:

For Mount Airy granite delivered on the river bank (steamboat landing) at Fayetteville, in carload lots, $1.51 per ton of 2,240 pounds.

For Sanford brown stone, weighing 156 pounds per cubic foot, and delivery as above, $1.34 per ton of 2,240 pounds.

The estimated cost of loading, towage, and placing on jetties is from $1.15 to $1.25 per ton, making cost in place $2.59 per ton at Elizabethtown. The stone is superior to any that can be obtained along the river, and is bought and used only as needed. It is probable that it will be advantageous to purchase brush and other supplies by the same method.

During the past year there has been practically no low-water season, and the present condition of the river is such that it has been navigable for light-draft boats all

the year and for 5-foot draft steamers during eleven months of the year to Fayetteville.

The plant now in use consists of one steamer (*H. G. Wright*), one steam hoister, and two scows or flats. Of these the *Wright* has been repaired, so that it is in fair condition; the hoister needs a new "A" frame and repairs to hull; the scows are worthless.

The value of the plant is estimated at $4,420.77.

A list of steam vessels plying over this river is appended to this report.

The expenditures of the year have been—

For snagging in river	$750.83
For jetty work	2,883.22
Total	3,634.05

Distributed as follows:

Superintendence	993.62
Plant	457.61
General work	2,182.82

Very respectfully, your obedient servant,

E. D. THOMPSON,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

List of steam vessels plying on the Cape Fear River, North Carolina, above Wilmington, for fiscal year ending June 30, 1892.

Name of vessel.	Net tonnage.	Remarks.
D. Murchison	140.72	Regular steamers between Wilmington and Fayetteville, N. C., four trips per week.
A. P. Hurt	140.11	
Cape Fear	156.32	
Navassa	3.00	Towing between Navassa and Wilmington, N. C.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$312,175		$312,175	7,658
Tobacco	10,000	$15,000	25,000	50
Rice	15,000	10,000	25,000	179
Grains and forage	2,000	75,800	77,800	1,930
Vegetables and truck	18,000		18,000	240
Live stock and products	7,800	80,000	87,800	539
Fish, oysters, etc		4,000	4,000	40
Naval stores	354,000		354,000	13,286
Lumber and products	139,600		139,600	41,715
Fertilizers		150,000	150,000	6,000
Machinery	40,000	40,000	80,000	2,500
General merchandise	110,000	542,200	652,200	12,000
Sundries	30,210	30,000	60,210	2,500
Total	1,038,785	947,000	1,985,785	88,638

Decrease over last year $28,651.

Transportation lines established during year, none.

The above statistics are based mainly upon reports of Assistant Engineer E. D. Thompson, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Cape Fear River, above Wilmington.

APPROPRIATED.

Date.	Amount.	Aggregate.
March 3, 1881	$30,000	$30,000
August 2, 1882	30,000	60,000
July 5, 1884	5,000	65,000
August 5, 1886	11,250	76,250
August 11, 1888	12,000	88,250
September 19, 1890	15,000	103,250

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1882		
1883	$14,813.96	$14,813.96
1884	12,987.45	27,801.41
1885	14,701.13	42,502.54
1886	16,511.29	59,013.83
1887	5,516.98	64,530.81
1888	1,302.13	65,832.94
1889	8,019.68	73,852.62
1890	9,469.69	83,322.31
1891	4,648.95	87,971.26
	6,379.17	94,350.43

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1881		
1885	50,000	$800,000
1887	....	2,238,800
1888	....	2,047,996
1889	....	2,710,357
1890	....	2,911,000
1891	....	2,518,045
	129,000	2,014,436

L 19.

IMPROVEMENT OF CAPE FEAR RIVER, AT AND BELOW WILMINGTON, NORTH CAROLINA.

The Cape Fear River is under improvement by the United States from the ocean bar, 145 miles, to Fayetteville, the appropriations being made separately for the part above and for the part at and below Wilmington.

From Point Peter between the Cape Fear and its northeast branch, and at their confluence opposite Wilmington, the distance by river to the ocean bar (2 miles seaward from its mouth) is 30 miles, nearly south.

Its width is 1,200 feet at Point Peter, 640 feet where narrowest at Wilmington, increasing to 1,400 feet in its upper 4 miles to near the mouth of Brunswick River, which is a branch of the Cape Fear 5¾ miles long and leaving it 4½ miles above Point Peter.

Below the mouth of Brunswick River, the ultimate junction of the Upper Cape Fear, the river is a broad and shallow estuary, its width in the next 9 miles varying from 1 to 1¼ miles, below which it is 1⅛ to 2¼ miles.

Its right bank for the upper 12 miles is low and swampy and the land

adaptable to the culture of rice, which is grown to some extent along the river. The rest of its right bank and its left bank are generally higher and sandy.

The range of tides is 4.5 feet on the bar and 2.5 feet at Wilmington, and although perceptibly is not materially increased at Wilmington by freshets.

Between the years 1823 and 1829 the State of North Carolina made an unsuccessful attempt to improve the river, principally by closing Brunswick River near its head and by works of contraction on the shoals between the mouth of Brunswick River and Campbells Island, 5 miles below, "upon which at that time there was only 7½ feet of water at low water."

The United States commenced the work of improving the river between Wilmington and the bar in 1829, and began the improvement of the bar in 1853, at which dates their condition was as follows:

In 1829 the navigation of the river was "so obstructed as to prevent the approach of all vessels drawing more than 10 feet water; that vessels of that description can not approach the town, and are obliged to anchor 14 miles below it and discharge part of their cargoes into lighters."

In 1853 there was in the channel on the bar, by the survey of 1852, at low water 7½ feet of water in the eastern channel and 7 feet in the western channel at the main outlet at the mouth of the river and 8 feet at the New Inlet, about 7 miles above the mouth, cut through the narrow beach and the ocean by a violent storm in 1761.

From the commencement of these improvements to this date the adopted projects and results have been in brief as follows:

The project of 1827 for the river, based upon surveys made in 1827, as directed by Congress in 1826, was to swell its volume by diverting into it, by jetties, water from Brunswick River and from Fishing and Rodman Creek, which flows through Eagle Island, opposite Wilmington, and by contracting the river by jetties below Wilmington.

In pursuance of this project and by some dredging from 1829 to 1838 between Wilmington and Campbell Island, 9 miles below, "an available increase of about 2 feet in depth was obtained, so that 9 to 9½ feet could be carried at low water."

The project of 1853 for improving the bar was to straighten the channel by building jetties along the inner shore of Baldhead Point, to deepen it by a wing dam to be built from Reeper Shoal, by dredging, by closing the narrower of two small breaches in Zekes Island near New Inlet, and by a jetty from Federal Point at the New Inlet to divert a large part of its ebb current through the main channel.

Work was confined principally to building, from 1853 to 1855, a stone jetty 300 feet long from Baldhead Point perpendicular to its outer shore (instead of the wing dam from Reeper Shoal), and to closing, between 1854 and 1856, both breaches at Zekes Island (united and much widened by storms meanwhile).

Simultaneously with the building of the stone jetty at Baldhead Point the western channel began to improve, and when the jetty attained a length of 300 feet, in 1854, its depth had increased to 9 feet (from 6 feet), and until 1855 ranged in depth from 8 to 10 feet, and "the eastern channel ceased to be used by vessels."

The Oak Island (western) channel deepened several feet simultaneously with the construction of the works for closing Zekes Island opening, and began to shoal again immediately after the destruction of these works.

The project adopted in 1870 was the closure of the breaches between Smiths and Zekes islands, with the ultimate closure of the New Inlet in view.

The closure of the breaches was commenced in 1870 and finished in 1873 by the construction of a line of crib-work filled with stones, 4,403 feet in length.

The project of 1873 added to the project of 1870—

That dredging be undertaken in the Baldhead Channel (which seems to be opening) as soon as funds are available for that purpose, the mode and amount of dredging to be left to the discretion of the superintending engineer.

That the closing work be continued according to the present plan to Zekes Island, and across the island and as far beyond it into the river as the superintending engineer may find expedient, the character of the construction across and beyond the island to be also determined by him.

That the closing of New Inlet is very desirable and should be attempted as soon as funds are available; that, with this object, a jetty should be commenced from Federal Point and follow the line of shoals in a general southwesterly direction.

Under this project the jetty (deflector) was commenced at Federal Point in July, 1873, and continued until November, 1873, when it had reached 500 feet in length and its construction was suspended.

The work of closing New Inlet was commenced in 1875, the closure completely effected in 1879, and the dam, 4,800 feet in length, finished in 1881.

In 1883 the New Dam, "to prevent the further erosion of Smiths Island at the swashes and extending from the large marsh 11,700 feet to Zekes Island," was commenced, and with "its extension across the island to connect with the New Inlet Dam, a distance of 1,092 feet," aggregating 12,792 feet, was completed in 1889, the two dams with their connection aggregating 17,592 feet (over 3.3 miles).

Dredging with the suction dredge *Woodbury* on the bar in the Baldhead channel was commenced August 13, 1874, and has since been continued, more or less, during the years 1875, 1876, 1879, 1880, 1881, 1887, 1888, 1889, 1890, and 1891.

The project of 1874 was "to get 12 feet at low water as high as the city of Wilmington," by dredging a channel 200 feet wide through Horseshoe Shoal below New Inlet, the "Logs," opposite Campbell Island, the shoal immediately below the "Logs," and the shoal immediately above the upper jetty, about 3 miles below Wilmington, and by the removal of obstructions placed in the river during the war near the latter shoal, at an estimated cost, including $12,000 for the maintenance of the suction dredge *Woodbury* for one year upon the bar, of $260,000.

Work under this project was commenced in March, 1874. September 18, 1874, the cutting of a channel behind the Horseshoe Shoal "to avoid the circuitous and variable Horseshoe Channel," opposite and below New Inlet, was commenced, and a channel 100 feet wide at bottom and 9 feet deep at low water was completed in May, 1875. Its enlargement to a bottom width of 190 feet and depth of 12 feet at ordinary low water was commenced August 9, 1875, and completed May 13, 1876, by the removal of over 280,000 cubic yards of material from a cut 1½ miles long.

With the finishing of this new Horseshoe Channel the depth of 12 feet prescribed in the project of 1874 was obtained from Baldhead Channel to Wilmington, with a width through the shoals varying from 125 to 245 feet, a greater depth than any record showed positively to have existed at any time before, and certainly greater than any time during the preceding fifty-four years.

The minimum depth at ordinary low water on the bar in Baldhead

Channel at that time was 11½ feet on the "inner lump," and was elsewhere not less than 12 feet.

August 6, 1881, the work of enlarging the cut through the Horse Shoe Shoal (known thereafter as Snows Marsh) to the width of 270 feet and depth of 16 feet at mean low water, was commenced and was the beginning of a project to obtain a channel 16 feet deep at mean low water from the deep water at Smithville to Wilmington by dredging a channel 2¾ miles in length through Horseshoe Shoal and through the following eight other shoals between that shoal and Wilmington, namely, Reeves Point, Midnight, Brunswick Cove, Lilliput, Logs and Big Island, Brunswick River, Kidder, and Wilmington shoals.

The enlargement of Snows Marsh Channel to the width of 270 feet and depth of 16 feet at mean low water was completed in December, 1883. It shoaled and was redredged in 1886, 1887, and 1888, and was abandoned in October, 1889, and the dredging of New Snows Marsh Channel in its place to the depth of 16 feet at mean low water and bottom width of 233 feet was commenced August 27, 1889, and finished May 20, 1890.

April 13, 1891, by dredging to a slight depth at Old Brunswick Cove Shoal, redredging at Lilliput Shoal and at New Snows Marsh Channel, a channel was finished to the full depth of 16 feet at mean low water and variable width of 233 to 270 feet from Southport (Smithville) to Wilmington, in completion of the foregoing project.

April 16, 1891, under a contract entered into with Mr. P. Sanford Ross by the officer then in charge, December 24, 1890, and approved January 8, 1891, the dredging of a channel from Wilmington to the bar 20 feet deep at mean low water and 270 feet in width was commenced at the Wilmington Shoal.

June 2, 1892, dredging to the depth of 20 feet in the Cape Fear River was discontinued, at which date a channel 20 feet deep and 270 feet wide had been finished through Wilmington Shoal, 3,200 feet long, and had been cut through the next two lower shoals at Alligator Creek and Brunswick River to the partial widths specified below in the recital of operations for the year.

June 9, 1892, the Chief of Engineers directed that a channel 18 feet deep and as wide as funds (in the next two years) will allow be dredged from the bar to Wilmington.

The redredging, commenced May 21, 1892, to the depth of 18 feet at New Snows Marsh Channel, where shoaling had reduced the depth of the 16-foot channel to 14½ feet at mean low water, was the virtual commencement of the dredging of an 18-foot channel under this modified project.

WORK OF THE FISCAL YEAR ENDING JUNE 30, 1892.

Dredging to obtain a channel 20 feet deep at mean low water and 270 feet wide was in progress under contract with Mr. P. Sanford Ross of December 24, 1890, from July 1, 1891, to June 2, 1892, during which time a channel 20 feet deep was finished to the full width of 270 feet through the shoal at Wilmington, and cut to the width of 148 feet through the shoal at Alligator Creek, and entirely through the shoal 7,700 feet in length at Brunswick River, 37 feet wide for a length of 3,464 feet and 74 feet wide for a length of 4,236 feet.

This project of increasing the depth of the channel from Wilmington

to the bar 4 feet (from a depth of 16 to a depth of 20 feet) and to a width of 270 feet involved dredging through ten shoals, aggregating 17.2 miles in length, and its completion would involve dredging, subsequent to June, 1892, amounting at the present contract price of 13¼ cents per cubic yard, with allowance for contingent and engineering expenses, to $791,947, and at the rate at which appropriations have hitherto been made would occupy at least ten years, or until 1902, until which date vessels could not reach Wilmington drawing any more water than at present and the commerce of the port derive no appreciable benefit from the money meantime applied.

If restricted to a depth of 18 feet at mean low water the dredging of a channel 270 feet wide could be completed through all the shoals between Wilmington and the bar at an estimated cost of about $440,000, while with $240,000 a channel 18 feet deep and 150 feet wide could be cut through them within two years after the money became available, permitting vessels of 2 feet greater draft than at present to reach Wilmington, and permitting the commerce of the port within a comparatively short time to realize the benefit of the money appropriated.

Several steamers of 1,800 to 2,500 tons net register, with a capacity of 9,000 to 12,000 bales of cotton on a draft of 18 feet of water, are now building for the Wilmington trade. A channel with a normal depth of 18 feet at mean low water, with the excess usually dredged to insure that minimum, together with the tidal range of 2½ and 4½ feet, respectively, at Wilmington and on the bar, will give vessels of the above class almost unrestricted ingress and egress, and is believed to be what the immediate interests of the port of Wilmington require.

On May 25, 1892, it was therefore recommended by the district engineer that the dredging be restricted to the depth of 18 feet, and that the United States suction dredge *Woodbury* be employed, as at present, toward securing 18 feet at mean low water on the bar, working in Snows Marsh channel when the sea prevents work upon the bar.

The recommendation was concurred in by the Division Engineer, who thought it "judicious to restrict the depth of dredging to 18 feet at low water from the bar to Wilmington with such funds as are now available, or are likely to be in the next two years," and who recommended—

> that the dredge *Woodbury* be worked on the bar when she can, to obtain as great depth as she can, not to exceed 18 feet at low water; elsewhere, when not on the bar, where her operations may be most advantageous; and that a channel 18 feet deep and as wide as the funds will allow be dredged from the bar to Wilmington, in order that the navigation be improved to that extent as soon as possible, it being left to the experience of the next few years to decide whether it be necessary or expedient to work for a greater depth.

The recommendation was approved by the Chief of Engineers, June 9, 1892.

A survey made in May, 1892, at New Snows Marsh Channel, revealed shoaling to the extent of about 94,000 cubic yards, the depth on the crest of the shoal at the southeasterly side being about 7.1 feet, in the middle about 13.9 feet, and along the northwesterly side 13.7 feet, but with a somewhat tortuous channel across the shoal not less than 14 feet deep at mean low water. An agreement with the contractor, supplemental to the contract, was entered into May 16 and approved by the Secretary of War May 20, 1892, providing for the transfer of one of the contractor's dredges to this shoal at $15.79 per hour, being the average earnings of the dredge for the preceding three months under the contract upon the shoals in the river above. The

redredging commenced May 20, and to June 30, 39,443 cubic yards had been removed from the shoal and redredging was still in progress, one cut 40 feet wide having been made through it to the depth of 18 feet, and another cut of the same width well advanced.

This new cut at Snows Marsh Channel had previously shoaled, and from February 23 to March 14, 1891, 8,808 cubic yards were redredged from it, making a channel 111 feet wide.

The United States suction dredge *Woodbury* has been engaged throughout the year in dredging in Baldhead Channel on the bar, and when the sea was too rough to work there upon the shoal in New Snows Marsh Channel, and has removed from the two channels during the fiscal year, 150,645 cubic yards.

At the date of this report, June 30, 1892, there is a depth at mean low water on the bar in the Baldhead Channel of not less than 17 feet, and of not less than 16 feet thence to Wilmington for a width of 270 feet, excepting upon the shoal in New Snows Marsh Channel, at which the minimum depth is 16 feet and the minimum width 40 feet, and excepting at Lilliput Shoal, 11 miles below Wilmington, where for a distance of 300 feet the minimum depth is 15 feet.

The minimum mid-channel depth is, therefore, on the bar 17 feet, and between the bar and Wilmington 15 feet.

The appended table shows the depths in the river and in the various channels on the bar prior to and since the commencement of the improvement to this date, from all accessible records.

The details of the work during the year are very fully presented in the appended report of Mr. E. D. Thompson, assistant engineer, who has had its immediate charge and assiduously conducted it.

The river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1891, balance unexpended		$128, 112. 62
June 30, 1892, amount expended during fiscal year		91, 762. 39
July 1, 1892, balance unexpended		36, 350. 23
July 1, 1892, outstanding liabilities	$19, 950. 52	
July 1, 1892, amount covered by uncompleted contracts	764. 64	
		20, 715. 16
July 1, 1892, balance available		15, 635. 07
Amount appropriated by act approved July 13, 1892		200, 000. 00
Amount available for fiscal year ending June 30, 1893		215, 635. 07
Amount (estimated) required for completion of existing project (approved by Chief of Engineers June 9, 1892)		101, 392. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894		101, 392. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Cape Fear River, North Carolina, at and below Wilmington, for the fiscal year ending June 30, 1892.

Up to July 1, 1891, the following work (then in use) had been completed on this river, the depths of all dredged channels referring to mean low water.

Locality of dredging.	Length of channel.	Depth.	Width.
	Feet.	*Feet.*	*Feet.*
Wilmington Shoal	2,100	20	270
Alligator Creek	700	16	270
Brunswick River Shoal	5,000	16	264
Logs and Big Island	8,500	16	270
Lilliput Shoal	11,000	16	270
Old Brunswick Cove	1,000	16	270
Midnight Shoal	7,400	16	270
Reaves Point	700	16	270
New Snows Marsh (bottom width)	9,600	16	233

A continuous stone dam 3¼ miles long, with a top width varying from 5 to 6 feet and rising 5.5 feet above low water, extending from Zekes Island to the marshes, had been completed. A channel had been dredged entirely across the bar; at the outer crest the least depth was 18 feet over a width of 200 feet, while on the inner shoals the available depth did not exceed 17 feet in a crooked channel. All work was in progress July 1, 1891.

Dredging under the project of 1889, to secure a channel of 20 feet depth at mean low water 270 feet wide from Wilmington to the ocean, continued under an unfinished contract with Mr. P. Sanford Ross, dated December 24, 1890, from July 1, 1891, to June 2, 1892, when the main contract was satisfactorily completed. During this period 405,227 cubic yards of sand, mud, and roots, 47 logs, 432 cypress and 21 pine stumps were removed from 54,300 linear feet of cutting 37 to 38½ feet wide, leaving channels through shoals as follows:

Name of shoal.	Excavated.	Logs.	Stumps, cypress and pine.	Cleared channel.		
				Length.	Width.	Depth.
	Cu. yds.			*Feet.*	*Feet.*	*Feet.*
Wilmington	48,881	6	....	3,200	270	20
Alligator Creek	222,890	10	....	9,900	148	20
Brunswick River	133,456	31	453	{ 3,379 4,321	37 *74	} 20

*Partially completed.

All the above work was done by two clamshell dredges, Nos. 5 and 7, No. 5 working continuously from July 1, 1891, to May 19, 1892, and No. 7 from January 4, 1892, to June 2, 1892.

The large number of stumps encountered at Brunswick River Shoal has materially increased the cost of work at that locality. The largest measured stump removed was 72 inches in diameter across the top and 12 feet in diameter across the roots; several others exceeding this in size were taken out, but being too heavy to be put on the deck of the scow, were lashed to it and thus taken to the dump ground. Besides the stumps at Brunswick River Shoal the dredge removed from the channel portions of an old war obstruction consisting of heavy 10 by 10 inch timbers, armed with railroad iron, and 150 yards of ballast rock. All material excavated was removed in scows, dumpage from Wilmington Shoal being put above Hilton Bridge in the Northeast River, and dumpage from Alligator Creek and Brunswick River Shoals being put in a slough near the mouth of Brunswick River, and in a pocket near the "Dram Tree."

Under a supplementary agreement entered into with the contractor May 16, 1892, Dredge No. 5 was on May 20, 1892, put to work redredging a shoal that had been formed in the lower part of the new Snow's Marsh Cut. Since that time 39,443 cubic yards of material have been removed, leaving a channel of 40 feet width and 18 feet depth entirely through the shoal. Dumpage was placed in the angle of the old Snow's Marsh Cut and on the west side of the deep-water pocket below the southern end of the same cut.

The suction dredge *Woodbury* has been employed almost continuously during the year in dredging in the Baldhead Channel across the bar and in the new Snow's Marsh Channel. In December the boat was laid up ten days for repairs, during which time a new rotary pump was put in and general repairs made to the hull, rudder post, and sheathing.

Following is a statement of the number of days worked and the material dredged by this boat during the year:

Month.	Dredging done and number of days dredged.				Total.		
	Bar.		Snow's Marsh.		Days.	Yards.	Cost.
1891.	*Days.*	*Cu. yds.*	*Days.*	*Cu. yds.*			
July	13	5,835.9	5	1,810.2	18	7,646.1	$1,258.12
August	8	3,517.4	14	5,410.4	22	8,927.8	1,019.71
September	20	7,572.8	3	810.8	23	8,383.6	1,051.52
October	4	1,687.4	19	7,186.0	23	8,873.4	1,042.16
November	12	4,576.5	10	2,955.9	24	7,532.4	1,869.75
December	5	1,958.9	9	2,818.3	*14	4,777.2	1,356.62
1892.							
January	12	4,909.3	13	3,955.2	25	8,864.5	1,181.37
February	10	4,861.4	12	3,814.2	22	8,675.6	1,118.67
March	14	6,211.9	10	3,741.3	24	9,953.2	1,265.34
April	5	2,485.6	20	10,281.2	25	12,766.8	1,250.74
May	2	1,040.1	17	9,406.0	†19	10,446.1	1,251.02
June	5	1,942.0	18	6,715.0	23	8,657.0	1,109.62
Total	110	46,599.2	150	58,904.5	260	105,503.7	14,774.64

* Laid up for repairs ten days. † Laid up for repairs four days.

The cost of operating this dredge has been $14,774.64, or at the rate of 14+ cents per yard of material excavated. This cost includes $100 to $150 per month for deterioration of plant, repairs of all kinds, superintendence, and all other expenses directly chargeable to the work. The amount of work performed is greater than that of any previous year in the history of the boat.

The work done on the bar has been the maintenance and deepening of a channel 200 feet wide and 17 feet deep from Baldhead to the ocean. The work in Snow's Marsh Channel was the maintenance of the dredged channel to its original depth and the partial removal of a shoal which was afterwards worked on under the supplemental agreement of May 16, 1892.

Examinations and surveys were made during the year of all the dredged channels, of the bar, the Baldhead beaches, the Snow's Marsh Shoal and vicinity, and of the dam. All the dredged channels are maintaining the dimensions to which they were originally dredged except as follows:

At Lilliput shoaling has occurred in the angle entirely across the cut to a minimum depth of 15 feet for a length of 300 feet; the eastern side of the lower reach has shoaled for its entire length (6,400 feet) for a width of 75 to 200 feet to an average depth of 14 feet. Excepting at the angle, there is still a continuous channel entirely through the shoal of 16 feet depth with a minimum width of 70 feet for a short distance only. Some slight shoaling has also occurred in the upper reach but nothing that will affect navigation.

At Midnight, on the east side of the cut, at and below the angle, for a length of 1,300 feet and a width of from 50 to 150 feet, the minumum depth of water is 15.5 feet. There is also slight shoaling at the northern end of the upper reach.

At Snow's Marsh, two high shoals formed in the new cut during the year, one designated as "Shoal A," being on the eastward side of the cut near its lower entrance, the other "Shoal B," being in the west side of the cut in the immediate vicinity of Buoy No. 11. The *Woodbury* has worked on both these shoals at different times during the year, but in May, 1892, the situation became so serious at "Shoal A" that it was decided to redredge a channel 80 feet wide and 18 feet deep entirely through it. At Shoal B, the available channel width with 16 feet depth is now 100 feet, while at Shoal A there will be, at the completion of the present dredging, a channel of 80 feet width with 18 feet depth and of 122 feet width with 14 feet depth.

At all other places in the cut the average depth is over 16 feet for 233 feet width.

The Snow's Marsh Shoal is now the governing factor in the future improvement and maintenance of proposed channel depths of the river. The material of which it is composed consists of a fine sand mixed with a sticky mud; the sand yields quite readily to the action of the pump but the mud does not. While shoaling at this particular locality was expected on account of the new conditions of the river, its continuance may necessitate in the near future the construction of deflecting jetties and training walls to secure a permanent channel.

On the bar a gradual improvement in conditions is observable. While the available depth of water is no greater than last year, the channel on the outer crest has maintained its depth of 18.1 feet without aid from the *Woodbury*, the distance from the 20-foot curve inside to the 20-foot curve outside now being 750 feet. The deep water

pocket just inside the outer bar has extended itself inward 500 feet. The inner shoals, now 3,500 feet inside the outer bar, have gradually sharpened their crests under the action of the *Woodbury* assisted by the natural scour, while the work of the year has materially straightened the channel over them. These shoals carry 17 feet at mean low water. The main channel now in use in the vicinity of the shoals is to the westward of the center range lights.

The bar channel is also obstructed in the vicinity of the shoals by the wreck of an old gunboat, which lies about 100 feet to the westward of the center range lights. An effort was made during the past year to remove it by the use of the river plant, and portions of the boiler were taken out. The conditions attending the prosecution of the work were, however, unfavorable, and it was in November, 1891, temporarily abandoned. Available plant is unsuited to bar work and probably the most economical way to get rid of the obstruction is to contract with some one fully equipped with wrecking appliances to remove it.

The dam was in good condition when last inspected and it appears probable that the limit of subsidence was reached several years ago. The swashes appear to be steadily closing and the whole area included between the present beach line and the dam gradually shoaling. No material changes have occurred in the shore line of Zekes Island and Federal Point.

At Baldhead Point the beach remains in about the same condition as last year, excepting that some accretions have occurred on the seaside.

At Oak Island the beach line shows further erosion at the point and opposite Fort Caswell, while the accretion still continues to the westward towards Oak Island Light-house.

The condition of plant as a whole is only fair. The suction dredge *Woodbury* has now been in use on this river since 1873 and will soon require some extensive repairs. The steamer *Easton*, used as a dispatch boat and for towing, also begins to show signs of age in the hull. Both of these boats, however, still render excellent service. The launch *Oklahoma* is practically unserviceable; the hull is rotten and the boiler too small for the engine. Of the other plant 1 pile-driver, 1 coal and water scow, 1 drag scow, and 1 deck scow are in good condition; 7 other scows are fairly well preserved, while 1 steam hoister and 3 scows are worthless.

The plant is valued at $18,500.64.

The work still to be done under the present project approved June 9, 1892, to secure 18 feet depth at mean low water from the bar to Wilmington, and of as great width as funds will allow in the next two years, is estimated as follows for widths of 150, 200, and 270 feet:

Name of shoal.	Length of channel.	Excavation.		
		150 feet width.	200 feet width.	270 feet width.
	Feet.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Alligator Creek	8,860	....	58,000	136,090
Brunswick River	6,600	81,019	122,474	180,517
Logs and Big Island	11,000	234,166	312,222	421,500
Keg Island (extension of Lilliput)	3,300	71,042	94,722	127,875
Lilliput	12,600	382,222	509,629	688,000
Old Brunswick Cove	2,000	114,236	152,315	205,625
Midnight	9,500	191,389	255,185	344,500
Reaves Point	2,000	35,695	47,593	64,250
New Snows Marsh	11,300	396,111	528,148	713,000
Total	67,160	1,505,880	2,080,288	2,881,357

Appended to this report is a tabulated statement giving the names and tonnage of all steamers plying on the Cape Fear River.

The expenditures of the year have been $97,850.64, viz: For dredging in river, $88,647.51; for work on the bar, $9,203.13, as follows:

For construction and general repair of plant	$958.29
For care of property	2,253.50
For general superintendence	5,633.76
For detailed surveys	1,067.86
For contract work	74,760.06
For other general work	13,177.17
Cost of contract dredging per yard (all expenses) ....cents..	.16
Cost of dredging per yard by United States suction dredge *Woodbury*, cents	.14

The work done on this river to date has given across the shoals a continuous channel of 20 feet depth with width varying from 270 to 37 feet from Wilmington 7 miles to Logs and Big Islands shoal; thence 16 feet depth and width varying from 70 to 270 feet 13 miles to Snows Marsh, excepting 300 feet in length at Lilliput Shoal, where the depth is 15 feet; thence 16 to 18 feet depth with width varying from 80 to 233 feet 9 miles to ocean bar, and thence a least depth of 17 feet with a width varying from 100 to 300 feet to sea.

Messrs. D. S. Bender, O. B. Fulford, inspectors; Capt. J. W. Woodside, Robt. C. Merritt, and Miss Florence Willis have had charge respectively of dredging operations, the *Woodbury*, surveys, and the clerical work, and all have rendered efficient service.

Very respectfully, your obedient servant,

E. D. THOMPSON,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

List of steam vessels plying on the Cape Fear River, North Carolina, at and below Wilmington, or regularly entering the Port of Wilmington, N. C., during the fiscal year ending June 30, 1892.

Name of vessel.	Net tonnage.	Ports between which they ply and number of round trips made.
Blanche	47.12	Harbor and sea towing.
Alex. Jones	69.37	Do.
Italian	29.37	Do.
Compton	53.94	Harbor towing.
Marie	13.35	Do.
Lawrence	10.54	Do.
Chas. Killam	6.66	Do.
Pastime	14.14	Pleasure boat.
Anna	30.32	Harbor towing.
C. F. D	4.00	Do.
F. & F	9.10	Do.
Navassa	3.00	Do.
Boss	5.00	Pleasure boat.
Wilmington	110.09	1 daily trip to Southport, 8 months; 3 daily trips to Carolina Beach, 4 months.
Passport	42.83	1 daily trip to Southport 4 months; 1 daily trip to Carolina Beach, 4 months.
Acme	18.64	Semiweekly trips to Town Creek until March, 1892.
Maggie	39.15	Semiweekly trips to Long Creek until February, 1892.
Pender	14.03	Irregular trips up North East River.
Delta	48.95	Semiweekly trips to Point Caswell until March, 1892.
W. T. Daggett	50.57	Semiweekly trips to Point Caswell since March, 1892.
Lisbon	66.94	Semiweekly trips to Clear Run.
A. P. Hurt	140.11	Regular steamers between Wilmington and Fayetteville, N. C. 4 trips per week each way.
Cape Fear	156.32	
D. Murchison	140.72	
Benefactor	637.79	New York and Wilmington S. S. Co. 2 trips per week to February 15, 1892: Since then 1 trip per week between New York and Wilmington. Between Wilmington and Georgetown, 2 trips per week to February 15, 1892; since then 1 trip per week.
Pawnee	858.94	
Croatan	827.25	

Depth of water from the ocean to Wilmington in the Cape Fear River, North Carolina, from 1733 to 1892.

[Depths refer to mean low water unless otherwise stated. Average rise of tides at the bar, 4½ feet; at Wilmington, 2½ feet.]

Year.	On the bar.			New inlet.	Channel depths bar to Wilmington.	Authority for statement.
	Bald-head (east) channel.	Oak Island western channel.				
		Outer bar.	Inner bar (rip).			
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1733..	14		9			Edward Mosely.
1738..	16		9		13	James Wimble.
1794..	10		6			Capt. N. Holland.
1797..	15		3	6		Joshua Potts.
1820..	9	6				Maj. Kerney, U. S. Topographical Engineers.
1823..	10½				*7½	Hamilton Fulton.
1826..					†10	Petition to Congress by citizens.
1827..					†9.2	Lieut. A. J. Swift, U. S. Engineers.
1836..					†12.5	Do.
1838..					†13	Walter Gwynn and others.
1839..	8	9	9	10		Capt. Glynn, U. S. Navy.
1850..	8		9½	7		Pilots and others.
1851..	8	8	7	8		U. S. Coast Survey, Capt. Maffit.
1852..	7½		7	8		Do.
1853..	8					Prof. A. D. Bache and others.
1853..					*7½	Col. de Russey.
1854..			9			Capt. Woodbury.
1855..			8-10			Do.
1858..	8	8	7	8		U. S. Coast Survey chart.
1866..	8	8	7	8	9	Do.
1871..	7	12¾	9½			Do.
1872..	9		9	10		W. I. Vinal, U. S. Coast Survey.
1873..	9					Capt. C. B. Phillips.
1874..	10		9		9	Do.
1875..	11½				9	Do.
1876..	11-11½				12	Annual Report 1876.
1877..	10½		8½	7.4	11	Annual Reports and maps of H. Bacon.
1878..	9		10½		11	Annual Report 1878-'79.
1879..	11	12	7-8	Closed..	11	Annual Report.
1880..	13	12	7-9		11	Do.
1881..	14	12	6½		11	Do.
1882..	14	12	6½		11	Do.
1883..	14	12	6.5		12	Do.
1884..	14				12	Do.
1885..	14				12	Do.
1886..	13.5	14	7-8		16	Do.
1887..	14				14	Do.
1888..	15				14	Do.
1889..	15½				14	Do.
1890..	17				16	Do.
1891..	17				16	Do.
1892..	17				‡15	Do.

* Low water.
† High water.
‡ This depth is for a distance of 300 feet only; everywhere else the depth is not less than 16 feet.

Commerce, foreign and domestic, for the years ending December 31, 1890 and 1891.

Articles.	Quantity.		Rate.		Value.		Tonnage 1891.
	1890.	1891.	1890.	1891.	1890.	1891.	
Exports.							
Cotton ....bales.	154,666	194,742	$52.00	$40.75	$8,042,632	$7,935,737	48,685
Spirits turpentine .casks.	70,285	60,846	18.70	18.72	1,314,330	1,139,037	10,648
Rosin ....barrels.	385,523	304,818	1.09	1.34	420,220	408,456	50,295
Tar ....do..	71,949	70,866	1.47	1.71	105,765	121,180	9,921
Crude turpentine ....do..	19,082	15,803	1.99	2.10	37,973	33,186	2,172
Lumber........... M feet.	40,065	29,580	13.00	17.08	520,852	505,226	51,765
Pitch ....barrels.	5,315	5,275	1.60	2.73	8,504	14,401	737
Peanuts ....bushels.	73,121	87,271	1.40	.60	102,369	52,363	1,220
Cotton goods.......cases.	....	2,480	....	120.00	....	297,600	744
Yarns ....packages.	....	536	....	70.00	....	37,520	161
Paper stock..........do..	....	1,687	....	5.00	....	8,435	169
Shingles ....M.	8,935	5,959	5.00	5.72	44,675	34,085	1,438
Spirits turpentine..cases.	....	11	....	4.00	....	.44	2
Tar ....do..	....	2,925	....	2.00	....	5,850	146
Miscellaneous............	....	....	....	....	3,500,000	4,000,000	53,334
Total.............	....	....	....	....	14,097,320	14,593,120	231,437
Imports.							
Miscellaneous (estimated)	....	....	....	....	7,350,000	8,500,000	113,306
Total exports and imports.							
Total commerce, 1891	....	....	....	....	....	23,093,120	344,743
Gain over last year.......	....	....	....	....	....	1,645,800	−1,814

Foreign commerce for 1891.

Articles.	Quantity.	Value.	
		Exports.	Imports.
Cotton ....bales..	138,874	$5,659,552	....
Rosin ....barrels..	279,329	364,156	....
Tar ....do...	5,890	10,076	....
Pitch ....do...	131	358	....
Spirits turpentine ......gallons..	1,224,545	439,425	....
Lumber ....M feet..	14,281	224,006	....
Shingles ....M..	1,776	10,161	....
Miscellaneous	....	1,812	$200,762
Total	....	6,709,546	200,762

Statement of vessels of 100 tons and over at the port of Wilmington, for the years ending December 31, 1890 and 1891.

[Furnished by Capt. Joseph Price, harbor master.]

	1890.		1891.	
	Vessels.	Tons.	Vessels.	Tons.
American..................	223	104,493	252	107,901
Foreign...................	169	86,487	133	71,431
Total.................	392	190,980	385	179,332

Entrances, clearances, and vessels documented for years ending December 31, 1890 and 1891.

[From custom-house records.]

	1890.	1891.
Foreign:		
Entrance	169	132
Clearances	171	191
American;		
Entrances	223	*124
Clearances	229	*82
Total	792	529
Vessels documented	73	66

* These figures are complete as regards foreign vessels only. Vessels arriving and clearing to and for domestic ports are not compelled to enter and clear; therefore the number as above reported does not include all domestic vessels. All the above vessels are of 100 tons and upward.

Tonnage.

Vessels.	Foreign.		American.		Total.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	23	27,426	86	62,126	109	89,552
Barks	83	38,481	1	507	84	38,988
Brigs	13	3,391	5	1,505	18	4,896
Schooners	14	2,133	160	43,763	174	45,896
Total	132	71,431	252	107,901	385	179,332

The above statistics are based upon report of Assistant Engineer E. D. Thompson, after much correspondence and conversation with steamship agents, custom-house officials, harbor master, and prominent shippers and merchants.

Cape Fear below Wilmington.

APPROPRIATED.

Date.	Amount.	Aggregate.
Mar. 2, 1829 to July 22, 1854		* $363,228.92
July 11, 1870	$100,000	100,000.00
Mar. 3, 1871	75,000	175,000.00
June 10, 1872	100,000	275,000.00
Mar. 3, 1873	100,000	375,000.00
June 23, 1874	150,000	525,000.00
Mar. 3, 1875	150,000	675,000.00
Aug. 14, 1876	132,500	807,500.00
June 18, 1878	160,000	967,500.00
Mar. 3, 1879	100,000	1,067,500.00
June 14, 1880	70,000	1,137,500.00
Mar. 3, 1881	140,000	1,277,500.00
Aug. 2, 1882	225,000	1,502,500.00
July 5, 1884	200,000	1,702,500.00
Aug. 5, 1886	157,500	1,860,000.00
Aug. 11, 1888	245,000	2,105,000.00
Sept. 19, 1890	170,000	2,275,000.00

* Balance of $3,728.07 turned over to surplus fund.

Cape Fear below Wilmington—Continued.

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1829 to 1858		$359,500.85
1871	$102,514.18	102,514.18
1872	75,436.49	177,950.67
1873	106,112.65	284,063.32
1874	92,985.13	377,048.45
1875	86,664.12	463,712.57
1876	188,564.71	652,277.28
1877	67,290.47	719,567.75
1878	87,374.01	806,941.76
1879	131,467.06	938,408.82
1880	103,981.73	1,042,390.55
1881	89,559.13	1,131,949.68
1882	82,519.58	1,214,469.26
1883	119,638.22	1,334,107.48
1884	138,995.42	1,473,102.90
1885	159,256.03	1,632,358.93
1886	65,332.81	1,697,691.74
1887	76,254.51	1,773,946.25
1888	77,089.89	1,851,036.14
1889	52,888.33	1,903,924.47
1890	189,961.40	2,093,885.87
1891	65,648.74	2,159,534.61

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1870	220,000	$13,500,000
1871		30,886,928
1873		11,899,491
1874		12,500,000
1880		17,216,130
1886		16,330,000
1887		16,968,193
1888		19,654,738
1889		21,102,189
1890	325,512	20,246,664
1891	346,557	21,447,320

L 20.

IMPROVEMENT OF LOCKWOODS FOLLY RIVER, NORTH CAROLINA.

This stream flows into the Atlantic 12 miles west of the mouth of the Cape Fear River.

It is navigated by three small vessels from its mouth, about 23 miles by river, to Lockwoods Folly Bridge. Above this bridge and for about 13 miles below it, the stream flows through a thickly timbered swamp, on emerging from which it sweeps in the remaining 10 miles to the ocean in large "oxbows" back and forth through a broad marsh bounded by pine barrens on either side.

Its navigable part is midway between and only 15 miles from the Cape Fear River on the east and the Waccamaw River on the west, which have been improved by appropriations aggregating to this date, respectively, $2,378,250 and $77,900. It is so tortuous its navigable length of about 23 miles penetrates only about 8 miles in an air line from the coast, and the arable land upon which its commerce, excepting lumber and naval stores, must depend is restricted between the sterile belt of sand barrens along the coast to the south and the extensive tracts of swamp about its source. (See accompanying section from the

map of the State of North Carolina.) The country between it and the Cape Fear River is sparsely populated, little cleared, little cultivated, and very sandy and poor, but the dry and practicable land which, at a few points, penetrates the swamp to the river on its other (west) bank, is said to give access to quite extensive and fertile farms.

The production of naval stores, said to have been large in the region of this river, is there, as elsewhere in North Carolina, now in decadence from the approaching exhaustion of the forests, Savannah having some years ago supplanted Wilmington as the leading market for naval stores in the United States.

From a point about 7 miles above the bridge down to within 3 miles of its mouth the width of the river ranges from about 70 to about 200 feet, and the depth of its channel from 8 to 15 feet, being at low water not less than 5 feet, except for about 300 feet near Dixons Landing, where it is only 3.5 feet. About 2,000 feet below Dixons Landing and 3 miles above its ocean bar, the river spreads to the whole width of one-fourth to three-fourths of a mile between the pine barrens and flows with an average depth of less than 1 foot at low water for 1¼ miles over mud flats and beds of oyster rock. Below these flats, which are known as Cross Rock Shoals, the channel is 5 to 12 feet deep at low water for 1½ miles to its ocean bar. On the bar the least depth in its shifting channel at low water was, in January and February, 1892, 5.5 feet.

The mean rise and fall of the tides on the shoal within the bar is about 3½ feet.

The project of 1887, not since modified, is to dredge a channel 100 feet wide and 7 feet deep at low water through the Cross Rock Shoal to permit vessels to draw 6 feet 23 miles to Lockwoods Folly Town Bridge, at a cost estimated in 1887 at $40,000.

During the fiscal year ending June 30, 1892, a cut aggregating 2,530 feet in length, 40 feet wide, and 5 feet deep at low water was made partly through the shoals by the removal of 20,777 cubic yards of oyster shells, sand, some mud, and a species of shell rock, the material being dumped in an embankment alongside the cut. The work was done by the Atlas Dredging Company under a contract entered into with them December 24, 1890, by the officer then in charge, and approved February 7, 1891. Dredging commenced January 4 and ceased February 23, 1892, about exhausting the appropriation of $5,000 made by the act of September 19, 1890, the only sum thus far appropriated for the improvement.

To connect the channel 5 feet deep at low water below the shoals with that of the same depth above them, giving a continuous channel of not less than that depth from the ocean 23 miles to the bridge, the highest point to which the river has been navigated, the cut dredged as above will have to be prolonged at Cross Rock Shoals 1,500 feet down stream and 4,400 feet up stream, and a cut 300 feet long will have to be made at Dixons landing where the low-water depth, as above stated, is only 3.5 feet.

The aggregate length of the cut when completed will be 8,530 feet, and if dredged according to the approved project to the width of 100 feet and depth of 7 feet there will still have to be removed 216,000 cubic yards at an estimated cost of 25 cents per cubic yard, amounting, with allowance for engineering and contingent expenses, to $60,000, which, with the $5,000 hitherto applied, will make the aggregate cost of the improvement $65,000.

There has been no steamer on the river for many years, and the only vessels now navigating it are three, as follows:

The sharpie *Harvest*, of 24.69 tons net register, the sharpie *Nancy Ann*, of 14.39 tons net register, and the schooner *Samuel*, of 17.5 tons net register.

The *Samuel* can carry 225 barrels of naval stores and the *Nancy Ann* about 10 cords of wood, and both ply between Lockwoods Folly and Wilmington, making a round trip each in about a week or ten days. The *Harvest* can carry about 28 cords of wood and runs to Southport (just within the mouth of the Cape Fear River), making a round trip in about two weeks.

These vessels, it is said by the master of the *Nancy Ann*, pass with facility through the cut dredged as above, sailing through it with fair wind or drifting through with the strong current in the cut when the tide is favorable, or poling through on slack water, for which they can wait without material detriment to any important interest.

The cut can be extended entirely through the shoals to a total length of 8,530 feet with present width of 40 feet and present minimum depth of 5 feet at low water by the removal of (approximately) 54,475 cubic yards, amounting, at an estimated cost of 35 cents per cubic yard, with increase for engineering and contingent expenses, to $25,000, making with the $5,000 already applied, the final cost of the improvement $30,000, providing the $25,000 be appropriated at one time. If the money be appropriated and applied in instalments the cost will be much increased.

June 30, 1892, on the 6,200 feet of shoals still to be dredged, for a distance of 4,500 feet, the depth of water at low tide does not exceed 1 foot.

If, after considering all the foregoing facts, it be the purpose of the Government to continue this improvement, it can be effected with least expense by applying $25,000 in one contract to the completion of the channel 40 feet wide and 5 feet deep.

The details of the work are given in the appended report of Mr. E. D. Thompson, assistant engineer, who has faithfully and efficiently exercised its immediate supervision.

The river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1891, balance unexpended	$4,980.19
June 30, 1892, amount expended during fiscal year	4,944.51
July 1, 1892, balance unexpended	35.68
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,035.68
Amount (estimated in 1887) required for completion of existing project	32,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. E. D. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., June 30, 1892.

MAJOR: I have the honor to submit the following report on the improvement of Lockwoods Folly River, North Carolina, for the fiscal year ending June 30, 1892.

Up to June 30, 1891, no actual work of improvement had been begun on this river.

The main obstruction to the navigation of this stream is found in an aggregation of oyster rocks and an extensive mud flat commencing about 1¼ miles from the ocean bar and extending upstream about 1¼ miles to the marshes. This mud flat and rock barricade is designated as Cross Rock Shoals. It has a width of from one-half to three-quarters of a mile, and carries an average depth at low water of less than 1 foot. Above the shoal the river is contracted to a width varying from 70 to 200 feet, and is from 8 to 15 feet deep, excepting at a point near Dixons Landing, about 2,000 feet above Cross Rock Shoals, where the depth is only 3.5 feet over a distance of about 300 feet. Below the shoal the channel is from 5 to 12 feet deep at low water as far as the bar. The bar channel is somewhat obstructed by two wrecks, but is comparatively easy to enter by such vessels as now navigate the river, its low-water depth being 5.5 feet as determined by soundings taken from the dredge while passing in and out in January and February, 1892.

The project of 1887 proposed to secure a 6-foot navigation at low water from the bar to Lockwoods Folly Bridge by dredging through the Cross Rock Shoal. The operations of the past year were the beginning of work under this project. All dredging was carried on under a contract dated December 24, 1890, with the Atlas Dredging Company, of Wilmington, Del., and covered the appropriation made by the river and harbor act of September, 1890. Under this contract the dredge *Vim*, commencing January 4 and finishing February 23, 1892, removed 20,777 cubic yards of material from a single cut 2,530 feet long of the specification dimensions of 40 feet bottom width and 5 feet depth at low water, the cut extending from the natural depth of 5 feet below Wild Horse Rock to the same natural depth above Genoa Point, the distance dredged being approximately one-third the entire length of the shoal. The excavated material was deposited in embankment on the west side of the cut, the crest of the dumpage being fully 50 feet from the edge of the cut and rising about 8 feet above low water. During the progress of the work a break 150 feet wide occurred in the dumpage, about 1,400 feet from its south end. A considerable volume of water passes through this break, but no filling of the cut has taken place. The dredged cut is so located that the dumpage from it forms a training wall from Genoa Point, where it connects with the shore line down to the marsh, opposite Wild Horse Rock. The effect of this wall is the development of a strong tidal current with a scouring power sufficient to move oyster shells. The material excavated proved to be a mixture of oyster shells, sand, some mud, and a species of shell rock very hard to dig and difficult to blast. Where the bottom and sides of the cut consist of this rock little erosion can be looked for.

While the channel was nominally dug to 5 feet depth and 40 feet width, it has practically 6 to 8 feet depth and 45 to 50 feet width, the contractors choosing to make it of the latter dimensions on account of the danger of dumpage flowing back into the cut.

The work done by the contractors is characterized throughout by much carefulness and thoroughness, and they are especially to be commended for the large amount of voluntary dredging at Wild Horse Rock outside the limits of the cut.

During the year a minor survey, having for its object the furnishing of data for the further prosecution of work was made from Dixons Landing, above Cross Rock Shoals, about 3 miles down the river to the bar, this survey embracing all portions of the Cross Rock Shoal, through which dredging is to be carried, and the channels below. A general inspection of the river from 8 miles above Lockwoods Folly River Bridge to the shoals was also made in May, 1892. This inspection showed that while the dumpage is gradually washing down to high-water level, the cut is deeper than when dug, and the channel on the whole steadily improving.

To secure a continuous 5-foot channel from the bar to Lockwoods Folly Bridge there still remains to be dredged 1,300 feet from deep water at Round Rock to the southern terminus of the cut, 4,400 feet from the northern terminus of the cut, to deep water in the marshes, and 300 feet across a shoal in the marshes near Dixons Landing. At these localities the present average channel depths are, respectively, 3.5, 0.7, and 3.5 feet. To dredge a channel 40 feet wide and 5 feet deep at low water through the above shoals will require the removal of (approximately) 54,475 yards of material at an estimated cost of $25,000 to cover all expenses if the work can be done under a single appropriation; to secure a channel of 100 feet width will require the removal of (approximately) 136,187 cubic yards, at an estimated cost of $55,000 if the work can be all done under one contract. The present needs of navigation do not, however, seem to justify the expenditure of more than enough to complete a channel of same dimensions as that already begun, while the economical prosecution of work will be best attained by a single appropriation of $25,000 to complete all work on this river for several years. Any less sum will fail to give any satisfactory navigation, and the nature of the improvement is such that no practical benefit will result until the work is completed.

No steamers ply on this river, the navigation being entirely confined to sail vessels. Information regarding them has already been forwarded to you.

The expenditures of the year have been for dredging in river, $4,795.76, as follows:

For dredging 20,777 yards, at 20 cents	$4,155.40
For general superintendence	487.67
For detailed surveys	152.69
Total	4,795.76

Actual cost of dredging, per yard, 23 cents.
Value of United States plant, nothing.
Dredging operations were carried on under the immediate supervision of inspectors John A. Dill and Robert C. Merritt, to whom thanks are due for the faithful services rendered.

Very respectfully, your obedient servant,

E. D. THOMPSON,
U. S. Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$4,000		$4,000	25
Tobacco		$1,500	1,500	5
Rice	50		50	1
Grains and forage	900	2,500	3,400	129
Vegetables and truck	900		900	38
Live stock and products	865		865	13
Fish, oysters, etc	9,325		9,325	290
Naval stores	24,750		24,750	1,497
Lumber and products	2,400		2,400	143
Fertilizers		2,000	2,000	100
General merchandise		27,775	27,775	552
Sundries (iron)		2,400	2,400	40
Total	43,190	36,175	79,365	2,833

Gain since 1887, $29,365.
No transportation lines established during year.
No actual work of improvement had been done up to December 31, 1891. The increase in commerce is due to its natural growth.
The above statistics are based mainly upon reports of Assistant Engineer E. D. Thompson, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Lockwoods Folly River.

Appropriated September 19, 1890	$5,000.00
Expended fiscal year ending June 30, 1891	19.81
Freight transported during fiscal year ending July 30, 1891 (7,000 tons)	50,000.00

L 21.

IMPROVEMENT OF YADKIN RIVER, NORTH CAROLINA.

The Yadkin and the Great Pedee are one river which flows from the Blue Ridge, in northwesterly North Carolina, about 465 miles to Winyaw Bay, in South Carolina. It is called the Great Pedee from the bay, about 194 miles, to the boundary between the two States, and the Yadkin thence to its source.

The Great Pedee is navigable for boats drawing 3½ feet throughout the year to Cheraw, 194 miles from its mouth.

The Yadkin is described as "a swift, turbulent, and unnavigable stream. Its valley is fertile and abounds in mineral wealth."

The project of 1879 was to secure a minimum depth of 2½ feet at ordinary stages nine months annually throughout the 64½ miles next above the railroad bridge at Salisbury by building wing dams and training walls, and by cutting through rock and gravel bars, at an estimated cost of $400,000. The present project (of 1887) is to restrict the foregoing work to the 33 miles next above the railroad bridge at Salisbury, the cost of which is estimated at $107,000.

Between the 33 miles of river under improvement and Cheraw, the head of navigation from tide water, there intervenes a section of the river 111 miles long, containing many shoals, rapids, and falls, which entirely preclude any attempt to make it navigable. The part of the Yadkin under improvment by the United States, therefore, not only lies far within the State of North Carolina, but is far remote from any navigable channel connected with tide water, and constitutes, by the definition of the Supreme Court of the United States (Treasury Decisions 1613 in 1873, 4376 in 1880, Navigation Laws of the United States, 1886, page 150), navigable water of the State of North Carolina in contradistinction from the navigable waters of the United States, which the court defines to "form in their ordinary condition, by themselves or by uniting with other waters, a continued highway over which commerce is or may be carried on with other States or foreign countries in the customary modes in which such commerce is conducted by water." The part of the Yadkin under improvement does not form by itself or by uniting with other waters such a continued highway.

During the fiscal year ending June 30, 1892, 392 linear feet of dams have been built and 216½ cubic yards of stone raised from the channel.

The work of improvement commenced in April, 1881, and after the expenditure of $101,544.18 there is, June 30, 1892, no steamboat upon it, and it has a channel 40 to 70 feet wide, 2 to 2½ feet deep; about eight months annually navigated only by flat and pole boats.

The river is in the fifth collection district of North Carolina.

Money statement.

July 1, 1891, balance unexpended	$3,460.20
June 30, 1892, amount expended during fiscal year	3,004.38
July 1, 1892, balance unexpended	455.82
July 1, 1892, outstanding liabilities	57.25
July 1, 1892, balance available	398.57
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,398.57

Yadkin River, North Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
Mar. 3, 1879	$20,000	$20,000
June 14, 1880	20,000	40,000
Mar. 3, 1881	12,000	52,000
Aug. 2, 1882	25,000	77,000
Aug. 5, 1886	10,000	87,000
Aug. 11, 1888	10,000	97,000
Sept. 19, 1890	5,000	102,000

Yadkin River, North Carolina—Continued.

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1881	$8,380.89	$8,380.89
1882	25,683.91	34,064.80
1883	10,063.31	44,128.11
1884	9,573.29	53,701.40
1885	8,574.65	62,276.05
1886	6,339.85	68,615.90
1887	8,650.00	77,265.90
1888	7,692.02	84,957.92
1889	7,149.83	92,107.75
1890	4,342.73	96,450.48
1891	2,521.06	98,971.54

L 22.

IMPROVEMENT OF HARBOR AT GEORGETOWN, SOUTH CAROLINA.

Georgetown Harbor is that part of the Sampit River at Georgetown and immediately above the bar at the confluence of the river with Winyaw Bay. It is about 120 yards wide, with a channel depth of 16 to 37 feet at ordinary low water.

About 1 mile above the mouth of the Sampit the bay receives at its head the Pedee and Waccamaw rivers.

Georgetown is about 15 miles from the ocean, is a railroad terminus, had a population of 2,557 in 1880 and of 2,895 in 1890, and is the seaport for all the traffic on the three rivers and their large tributaries.

When in 1881 a survey with estimate of the cost of improving the entrance of the harbor was made, pursuant to the act of June 14, 1880, the depth in the channel on the bar at the entrance to Winyaw Bay was about 8¾ feet at mean low and about 12 feet at high water; thence up Winyaw Bay to the bar at the mouth of the Sampit there was a channel depth not less than 13 feet at low water, but upon the latter bar only 9 feet at ordinary low water.

The project of 1881, not since modified, was to dredge a channel 200 feet wide to the depth of 12 feet at ordinary low water 2,850 feet in length through the shoal at the mouth of the Sampit River.

The cost was then estimated at $14,151.94 for dredging "sand and sand mixed with mud" found on the bottom.

The commencement of dredging and examination that followed it revealed in the projected channel a large number of cypress stumps, which thickly covered the lower part of the shoal and increased the cost of the improvement, as estimated in 1889, to $44 500.

Nineteen thousand dollars having been appropriated ($7,000 by the act of August 2, 1882, and $12,000 by that of July 5, 1884), dredging was commenced in December, 1884.

To June 30, 1891, a channel 12 feet deep had been dredged entirely through the bar, with a minimum width of 80 feet, increased for a part of its length to 100 feet.

Under contract entered into December 24, 1890, with P. Sanford Ross, the sum of $8,000 appropriated by the act of September 19,1890, was applied to dredging and redredging, which commenced November 17 and ended December 11, 1891. The details of this work are fully given in the appended report of Mr. Reid Whitford, the very efficient assistant engineer who has had its immediate supervision.

June 30, 1892, the minimum width of the channel dredged to the depth of 12 feet through the bar is 130 feet.

Georgetown is a port of entry.

Money statement.

July 1, 1891, balance unexpended	$8,564.27
June 30, 1892, amount expended during fiscal year	8,189.39
July 1, 1892, balance unexpended	374.88
July 1, 1892, outstanding liabilities	16.00
July 1, 1892, balance available	358.88
Amount appropriated by act approved July 13, 1892	12,000.00
Amount available for fiscal year ending June 30, 1893	12,358.88

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

MAJOR: I have the honor to make the following report upon harbor at Georgetown, S. C., for fiscal year of 1891-'92:

Surveys.—During October and November last a survey was made of the dredging ground at mouth of the Sampit River. Map of same has already been forwarded to your office.

Contract work.—P. Sanford Ross began dredging under his contract November 17, 1891, and continued to the 11th of the following month, when the dredge was withdrawn owing to the exhaustion of the appropriation. During the time there was removed from the channel under process of improvement 13,448 cubic yards sand and mud, 142 cypress stumps measuring altogether 300.8 feet in diameter, and 14 logs measuring altogether 21 feet, thus deepening to 12.5 feet deep at low water 3,310 feet 40 feet wide; 2,500 feet 20 feet wide. This added 60 feet to the former width of the upper 2,300 feet of channel and 20 feet the remaining distance of 200 feet to deep water in Winyaw Bay.

The least clear width of the dredged channel is now 130 feet. The eastern side of the cutting had filled in some since the dredging of 1889, so that its available width was contracted from 110 to about 75 feet at several points. This was redredged, so that now the channel is in better condition than it has been at any previous time. The cost of work was greatly increased by the unusual number of cypress stumps and logs encountered and removed. The progress map for December, 1891, shows the work completed and that left to be done.

Commerce.—It is well known that the advantage to be derived by shipping from this improvement is that vessels will be enabled to leave Georgetown at dead low water and cross the bar 16 miles distant on the next high water. As it has been the case before any work was done by the General Government, vessels were compelled to leave this place at high water in order that they might cross the shoal through which the channel is now being dredged. This arrangement, of course, brought them to the bar after high water, and too late to go to sea on that tide. The result was that they had to wait for the next high tide. Such delays have been very annoying and extremely expensive. They are now avoided by the existence of the present dredged channel.

The accompanying commercial statistics were collected through the Georgetown Board of Trade, with the aid of Mr. W. D. Morgan, chairman of the commerce committee of that body. Mr. Morgan says he considers the figures correct. A letter from him sent herewith explains itself. One steamer has been built, but not yet put on a line of transportation. This new line will be established somewhat later in the year. The Clyde steamships have run regularly and profitably to New York. The usual river steamers and Charleston line of steamers, together with seagoing sailing vessels have been operated with great regularity and dispatch. The mills and factories have been profitably operated during the year.

In the calendar year of 1888 the commerce amounted in the aggregate to approximately 157,521 tons, in 1889 it was about 196,754 tons, in 1890 it was 241,648 tons, in 1891 it was 245,082 tons. This shows an increase of 87,561 tons over that of 1888, and an increase of 3,434 tons over that of 1890.

The accompanying statement of shipping was furnished by the custom-house collector of this place.

My thanks are due to employés under this office for cheerful performance of their duties.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$640,000	....	$640,000	4,000
Rice	415,000	....	415,000	4,665
Vegetables and truck	3,000	....	3,000	60
Live stock and products	750	....	750	4
Fish, oysters, etc	100,000	....	100,000	4,000
Naval stores	1,273,750	....	1,273,750	46,303
Lumber and products	602,000	....	602,000	60,970
General merchandise	1,600,000	$3,400,000	5,000,000	125,000
Sundries	20,000		20,000	80
Total	4,654,500	3,400,000	8,054,500	245,082

Gain over last year: $59,550; tons, 3,434.

Transportation lines established during year: None.

The above statistics are based mainly upon reports of Assistant Engineer Reid Whitford, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Georgetown Harbor, South Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
July 4, 1836	*$1,000	....
August 30, 1852	†3,000	$3,000
August 2, 1882	7,000	7,000
July 5, 1884	5,000	12,000
August 5, 1886	5,000	17,000
August 11, 1888	7,500	24,500
September 19, 1890	8,000	32,500

* Not used; turned over to surplus fund.
† Balance of $0.03 turned over to surplus fund.

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1853 to 1854	....	$2,999.97
1885	$8,433.85	8,433.85
1886	3,552.19	11,986.04
1887	4,636.46	16,622.50
1888	211.60	16,834.10
1889	7,008.53	23,842.63
1890	34.94	23,877.57
1891	58.16	23,935.73

Georgetown Harbor, South Carolina—Continued.

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1883	120,800	$4,000,000
1885		2,172,438
1886		3,757,273
1887		4,902,000
1888		5,402,000
1889		7,814,175
1890		7,919,700
1891		7,994,950

List of vessels plying between Georgetown, S. C., and other ports during the year ending December 31, 1891.

Names.	Net tonnage.	Running to—	Number of trips.
Steamers.			
Pawnee	858.25	New York via Wilmington	Weekly.
Fanita	432.43	do	Do.
Benefactor	843.55	do	Do.
Croatan	830	do	Do.
Planter	499.16	Charleston	Twice a week.
John M. Cole	318.41	Cheraw	Once a week.
Maggie	279.20	Conway	Do.
Driver	111.08	do	Do.
Ruth	89.85	do	Do.
Two Brothers	97.37	Black Mingo	Twice a week.
Wm. P. Congdon	84.48	Smiths Mills and Bar	Five times a week.
S. S. Brewster	59.61	do	Do.
Emma A. Twiggs	16.79	Black Mingo	Three times a week.
Maggie	72.63	Tributaries	Twice a week.
Janie	17.21	Bucksville	Three times a week.
Emma	19.86	Tributaries	Twice a week.
Wm. C. Turner	28.86	North Island	Do.
Fearless	18.92	Tributaries	Daily, eight months of the year.
Merchant	405.55	Cheraw	Once a week.
Henry Lloyd	13.01	Tributaries	Daily, eight months of the year.
Total steamers	5,046.22		
Sailing vessels.			
Mattie May	196	New York	Monthly.
B. T. Hazard	373	do	Do.
Waccamaw	436	do	Do.
Hattie L. Sheets	250	New York and Philadelphia	Do.
Anna M. Dickenson	205	do	Do.
John H. Cannon	220	New York	Do.
Ann E. Valentine	300	West Indies	Twice a year.
Edgar C. Ross	380	New York	Monthly.
Eleanor	340	do	Do.
Myra W. Spear	148	Boston	Do.
Nellie Floyd	435	New York	Do.
Jas. B. Anderson	155	do	Do.
Henry D. May	264	Banger	Do.
John C. Gregory	360	New York	Do.
J. H. Woodhouse	275	do	Once in three months.
James Ponder	258	Philadelphia	Do.
Edna and Emma	174	Baltimore	Do.
Jas. Waples Ponder	234	New York	Monthly.
Geo. R. Congdon	435	do	Once in four months.
Percy and Lillie	478	do	Do.
Anna V. Lamson	321	do	Do.
Dellie Gordon	225	New York and Boston	Do.
Rover Killingham	300	New York and Savannah	Three times a year.
Percy W. Schall	228	New York and Baltimore	Once in two months.
Lina C. Kaminski	421	New York	Once in three months.
Robert A. Snyder	357	Wilmington	Do.
John W. Hall	329	New York	Do.
A. E. Rudolph	250	do	Do.

List of vessels plying between Georgetown, S. C., etc.—Continued.

Names.	Net tonnage.	Running to—	Number of trips.
Sailing vessels—Continued.			
Etta H. Lister	313	New York	Once in three months.
A. Ball	450	......do	Do.
Alfaretta S. Snare	241	Boston	Do.
Eva A. Dannanhover	250	New York	Do.
William T. Parker	170	......do	Do.
Jesse W. Star	292	......do	Do.
Thomas S. May	213	Philadelphia	Do.
Annie Anislie	288	Darien	Do.
George Churchman	281	Philadelphia	Once in two months.
Abbie H. Gheen	239	New York	Monthly.
Henry H. Chamberlain	233	......do	Once in two months.
Samuel W. Hall	306	......do	Do.
Etta	50	Beaufort	Do.
B. Bacon	300	New York	Do.
Edwin A. Gaskill	333	......do	Do.
Mary M. Brockaway	500	......do	Once in four months.
Frank McDonnell	264	Philadelphia	Do.
Edward W. Young	399	Baltimore	Do.
Rillie S. Derby	398	New York	Do.
De Mory Gray	381	......do	Do.
Carrie Farson	100	North Carolina	Do.
Encore	16.65	Charleston and Santee	Twice a week.
Prosperity	15.41	Santee	Do.
Longfellow	7	North and South Islands	Daily.
Browx	23.72	Murrill Inlet	Once a week.
Chief	18.60	North Island	Semimonthly.
Winyah	18.16	......do	Do.
City of Jacksonville	337	Baltimore	Three times a year.
31 pole boats	755	Black River and tributaries	Once a week.
Total sailing vessels	15,539.54		

L 23.

IMPROVEMENT OF WINYAW BAY, SOUTH CAROLINA.

The entrance from the ocean to this bay is about 45 miles northeast from Charleston and about 71 miles southwest by west from the mouth of the Cape Fear River.

At its head, about 12 miles from the entrance, the bay receives the Waccamaw, Pedee, and Sampit rivers; it is also the commercial outlet of the Santee River through Mosquito Creek and Mosquito Creek Canal cut to connect the bay and river and avoid the extensive shoals off and within the mouths of the latter.

These four rivers with their large tributaries are reported to flow through an exceedingly fertile farming country and to be bordered by extensive forests of valuable timber.

The Waccamaw, Santee, and Pedee rivers flow entirely across the State of South Carolina and drain a very large part of its area.

The old colonial settlement of Georgetown at the mouth of the Sampit River having, by the United States census, a population of 2,557 in 1880, and 2,895 in 1890, is the only town upon the bay.

There are through the ocean bar two principal channels about 3 miles apart, with changeable depths, namely, the Main (southerly) Channel, and the Bottle (northerly) Channel. By the survey of 1885 the depth at mean low water varies in the former from 7 to 9 feet and in the latter from 6 to 8 feet; within the bar the entrance to the bay had at its throat a width of about 4,000 feet with an average depth of 21 maximum depth of 30 feet. From within the entrance to the head of the bay vessels could draw 12 feet at lowest tides.

Pursuant to the act of July 5, 1884, the bar was surveyed and a project for its improvement submitted by the officer then in charge in January, 1885.

This project was considered and approved by a Board of Engineer Officers convened pursuant to the act of August 11, 1888, who, in their report of December 24, 1888 (Annual Report Chief of Engineers, 1889, page 1114), recommended the construction of a north and south jetty, the south jetty to be built first.

The Chief of Engineers, April 11, 1889, approved this report, excepting the order of building the jetties, and directed that the north jetty be built first.

The project of 1885, approved as above by the Board of Engineer Officers in 1888 and by the Chief of Engineers in 1889, is to increase the depth of water to about 15 feet at mean low water in Bottle Channel by building to the height of 6 feet above mean low water to the 18-foot curve a north jetty 10,700 feet long from North Island, and a south jetty 17,500 feet long from South Island across the Main Channel, the jetties converging to 4,000 feet at the 18-foot curve, at a total estimated cost for the 28,200 feet of jetties of $2,500,000.

The first appropriation, by the act of August 5, 1886, of $18,750 was inadequate to the advantageous prosecution of work, and its application was restricted to a survey in 1886 of the site for the north jetty.

One hundred thousand dollars having been appropriated by the act of August 11, 1888, contract was entered into, August 28, 1889, with J. S. Howell of New York for $80,000 worth of work to be applied to the construction of the north jetty, which commenced in February 1890.

The contractor having proved unable to efficiently and satisfactorily prosecute the work, September 26, 1890, it was stopped, and October 24, 1890, the Secretary of War annulled the contract.

An additional $100,000 having been appropriated by the act of September 19, 1890, contract was entered into December 24, 1890, and approved January 14, 1891, with Mr. W. T. Gaynor for labor and materials to the amount of $170,000 to $180,000 to be applied to the north jetty.

The contractor commenced laying track and installing plant in March, and delivery of materials in May, 1891, and to June 30, 1891, under the two contracts the two wings and the jetty itself had been substantially completed to the low-water line.

WORK OF THE FISCAL YEAR ENDING JUNE 30, 1892.

With an adequate plant and efficient superintendence the contractor has prosecuted the work with much energy during the year.

From July 1, 1891, to June 30, 1892, he has delivered and placed in the jetty 46,276.49 tons (of 2,000 pounds) of large and small stone (40,757.86 tons small and 5,518.63 tons large), 141 cubic yards of oyster shells, 21,147.14 square yards of mattresses, and 194,976 feet B. M. of sheet piling extending (at 90 feet B. M. per linear foot) along 2,166 linear feet of jetty.

All of the foregoing materials have been placed seaward of the mean water line, except 871.29 tons of stone which were placed on shore on the jetty and its west branch.

The end of the jetty which was at the low-water line July 1, 1891, is on June 30, 1892, 2,090 feet seaward from it.

The top of the jetty is now, approximately, 18 inches above mean low water, and 4½ feet lower than the top when completed.

A part of the stone was brought by railroad from Columbia, S. C., and part of it by schooner from New York. The latter was delivered from the vessels into tram cars at the contractor's wharf on the island and dumped from them upon the jetty from a tramway built on piles driven along the harbor side of its axis, the stone being weighed in the cars on platform scales in the track between the wharf and the jetty. The stone from Columbia was towed on scows from Georgetown (12 miles) and delivered from the scows directly upon the jetty, being measured by displacement. It weighs 166 pounds per cubic foot. A volume of one cubic yard packed with it as nearly as is practicable in the jetty weighs 2,700 pounds. The volume of stone per cubic yard is therefore 60¼ per cent and the volume of voids 39¾ per cent.

The mattresses were made on the banks of the Sampit River, a little above its mouth, and towed about 14 miles to the jetty. They are 80 feet by 36 and 46 feet.

The contract price for the materials placed in the jetty seaward of the mean water line is, per ton of 2,000 pounds, for large stones weighing 1,000 to 6,000 pounds, $2.90; for small stone weighing from 20 to 400 pounds and averaging about 150 pounds, $2.50; for oyster shells, per cubic yard, $1.30; for mattresses, per square yard, 70 cents; and for sheet piling in place, $54 per 1,000 feet B. M., costing (for 90 feet B. M.) $4.77 per linear foot of jetty.

It was reported in January, 1892, by Mr. Charles Humphreys, assistant engineer in immediate charge of the work, that about five-sevenths of the oyster shells were carried away by the very strong current in which they were dumped, making a cubic yard of them in place on the jetty cost about $4.55, while a cubic yard of the small stones, weighing 2,700 pounds, would cost, at $2.50 per ton of 2,000 pounds, $3.37 per yard. Under article 5 of the specifications to the contract which permitted the amount of each kind of work to be varied during the progress of work according to the decision of the engineer in charge, the delivery of oyster shells was discontinued in November, 1891.

The project, submitted June 17, 1889, by the officer then in charge, for the application of the funds applied under the present contract prescribed that there be—

driven along the axis of the future dike (preferably by a water jet) a continuous sheet-piling wall of 6 inches thickness, to extend from the natural surface of the sand downward to about 15 feet depth below low-water level, * * * the object of this sheet-piling wall being to prevent undermining by water which would otherwise pass directly through the sand just below the lower course of an ordinary mattress and stone dike.

Whether or not, in the degree of exposure of the site, it would have been advantageous to build a tramway along the jetty for the delivery of the materials upon it, such a tramway became indispensable for driving the sheet piling, and cost the contractor about $3 per linear foot of jetty. In sinking the sheet piling, and also the piles for the trestle by the water jet, a large quantity of sand is displaced, and in the very strong current at the site the swirl of the water among the piles causes a very great amount of scour, which can not be prevented by sinking the mattresses in advance of the jetty and driving the trestle piles through them, for the reason that the sheet piling can not be driven through the mattresses.

To reduce the amount of this scour, and to effect the further saving of at least the cost of the sheet piling, it was recommended April 7, 1892, that it be discontinued. This recommendation was approved by the Division Engineer, and April 11, 1892, by the Chief of Engineers, but through an error in the transmittal of the indorsement it did not

reach the district engineer until June 22, and the discontinuance of the sheet piling could not be effected until the close of the fiscal year. The saving in the scour and in cost that can be effected by this omission will be ascertained on the resumption of work under the next appropriation.

If a trial of adjacent sections of the jetty with and without sheet piling prove the latter to be advantageous, notwithstanding whatever increase in scour it may cause, its driving may readily be resumed.

As will be seen from the accompanying longitudinal cross section, the scour deepens the water in which the jetty is to be built 5 to 10 feet before the mattresses are sunk.

For the 2,090 feet of jetty built during the fiscal year the contractor has been paid $145,795.55, being $69.75 per linear foot, which is increased by the cost of superintendence and engineering expenses to $73.74 per linear foot.

The average cost per cubic yard of jetty for stone and oyster shells in place is $3.47.

A wharf, 115 feet long and 7 feet wide, has been built for the use of the assistant engineer, and a room 10 by 18 feet added to his quarters at North Island.

June 30, 1892, the jetty had not extended far enough (only 2,090 feet from the shore) to have any perceptible effect upon the depth of water in Bottle Channel over the bar.

The report of Mr. Charles Humphreys, assistant engineer, who has very faithfully exercised the immediate supervision of the work throughout the year, is appended hereto.

SOUTH ISLAND BEACH.

The outer shore line from the entrance to the bay south for a distance of 3 miles is a low and slender bank of sand lying upon a marsh, with only the bar and intervening shoals interposed between it and the full force of the open ocean.

The bank of sand is the mere vestige of a range of sand dunes upon which there is said to have been years ago a growth of grass, and at intervals trees and brush, which have been gradually destroyed by winds and storm tides.

From this strip of 3 miles northerly along the throat of the bay and southerly to the Santee River there are now dunes of that description with grass and trees growing upon them.

As long as 11 years ago, in 1881, at occasional high tides the water poured over the 3 miles of sand beach at intervals of 200 or 300 yards. Its more or less gradual degradation since that date was very greatly accelerated by the prevalence, on forty-six days in March and April, 1892, of fresh easterly winds with heavy seas, and by two easterly gales. On the night of April 25, 1892, the tide rose to 6.2 feet on the gauge and swept over 12,000 feet of the sand beach, and on the night of April 26, it rose 0.6 of a foot higher, to 6.8 feet on the gauge, and swept over the crest of the beach along the entire 3 miles.

These two tides very greatly eroded the sand, and for a length of 500 feet swept it entirely away down to the marsh sod.

The marsh whose overflow, except at unusually high tides, has hitherto been prevented by the sand bank lies approximately 1 foot below mean high water by the automatic gauge record of 1891, 2.8 feet below the high tide of April, 1892, and 4 feet below the tide of February, 1892. It is about 5 miles wide from the bay south to the Santee River and stretches in extensive tracts of rice lands up along the latter.

South Island is that part of it between the ocean and Mosquito Creek, a bayou which, at a distance of from one-quarter to 2½ miles back from the ocean, connects the bay and Santee River.

An attempt to preserve the sand beach would involve great expense without certainty of success, while its destruction followed by the flow of water at mean high tides 1 foot deep and 3 miles wide over the marsh would materially alter the conditions influencing the tidal regimen of the bay and threaten detriment to it.

To prevent this overflow it was recommended, May 6, 1892, that a dike be built of the marsh soil in cross section, as shown by the accompanying drawing, and 12,000 feet in length, extending from the strip of higher ground above overflow at the northerly part of the island south to the narrow strip of ground above overflow upon which a plantation road, known as Ford's avenue, runs from the beach back into the marsh. The estimated cost of the dike was $35,280.

The recommendation was, upon the recommendation of the Division Engineer, approved by the Chief of Engineers May 10, and the sum of $10,000, the entire available balance of the appropriation, was allotted for building the dike to a partial cross section until further funds become available.

Title has been secured to so much of the necessary land, 1,000 feet wide, as lies north of the tract to which title was secured July 17, 1890, for the south jetty.

The tract required south of it has been surveyed, a site has been secured for temporary quarters in a more healthful location than the land conveyed for the dike, and work upon the dike will be commenced immediately upon the approval of the title by the Attorney-General.

In the five counties of Georgetown, Williamsburg, Berkeley, Horry, and Marion, nearest this bay, and through which flow the rivers naturally or commercially tributary to it, there were grown in 1889, by the United States census of 1890, upon 21,694 acres 17,540,058 pounds of rice, valued at $606,311.

Money statement.

July 1, 1891, balance unexpended		$191, 758. 81
June 30, 1892, amount expended during fiscal year		125, 633. 42
July 1, 1892, balance unexpended		66, 125. 39
July 1, 1892, outstanding liabilities	$34, 351. 18	
July 1, 1892, amount covered by uncompleted contracts	16, 242. 20	
		50, 593. 38
July 1, 1892, balance available		15, 532. 01
Amount appropriated by act approved July 13, 1892		100, 000. 00
Amount available for fiscal year ending June 30, 1893		115, 532. 01
Amount (estimated) required for completion of existing project		2, 181, 250. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894		250, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. CHARLES HUMPHREYS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
North Island, South Carolina, June 30, 1892.

MAJOR: I have the honor to make the following report of operations upon Winyaw Bay, South Carolina, for the fiscal year ending June 30, 1892.

STATEMENT OF WORK DONE.

Hired labor work.—Surveys were made of Bottle Channel Bar in October, and again in May and June, without disclosing any change of depth on the bar, but the north jetty as far as built is carrying a narrower channel with it. This increase of depth is shown on the maps herewith.

Numerous surveys of the shore line on North Island have been made; the high-water line on the eastward side of the jetty has advanced seaward 350 feet during the year.

Contour surveys and maps of South Island Beach were made in February and March. This beach is composed of marsh mud to an elevation of + 4 feet on the automatic gauge. On top of this mud, close to the ocean, there is a narrow strip of sand about 2 to 4 feet high which is overflowed during spring tides. The mud stands the action of the waves quite well, but the sand is cutting away gradually for a distance along the beach of 3½ miles. At several places the sand is cutting away rapidly. Surveys and maps for the right of way for 1,000 feet width along this distance have been made and sent you.

A mud dike has been determined on by you to protect this beach. This dike is to be ultimately 70 feet wide on base, 6 feet wide on top, where its elevation will be 12 feet on automatic gauge. Its construction to partial dimensions has been ordered by hired labor, $10,000 being allotted for the purpose. The dike has been staked out for a length of 8,000 feet and at a distance of from 500 to 600 feet from the edge of the marsh, and its construction will be commenced as soon as the authority for erection of laborers, quarters is received.

The automatic gauge has been kept during the year at North Island.

A boathouse and wharf for the use and preservation of launch and surfboat have been built, and the North Island quarters were enlarged and repaired.

The naphtha launch purchased by the Wilmington office has been used for all the survey work on the bar.

Contract work.—Mr. W. T. Gaynor, contractor, continued operations throughout the year on the north jetty.

The following work has been completed to date:

Stone work.—148.42 tons (of 2,000 pounds) of small stone ballast have been placed shoreward as follows: 92.30 tons on the west wing and 56.12 tons on the main jetty.

722.87 tons large stone have been placed shoreward as follows: 256.17 tons on the west wing and 466.70 tons on the main jetty.

40,757.86 tons of small stone ballast have been placed on the main jetty seaward from the low-water line at Station 5 + 60 to Station 27 + 35.

5,518.63 tons of large stone have been placed on main jetty seaward from low-water line to Station 27 + 35.

Mattress work.—21,147.14 square yards placed on main jetty from low-water line seaward to Station 27 + 35.

Oyster shells.—8 cubic yards placed on main jetty from low-water line shoreward; 133 cubic yards placed seaward.

Sheet piling.—194,976 feet B. M. sheet piling were driven from Station 5 + 70 seaward to Station 27 + 41.7.

GENERAL REMARKS.

All work completed has been well and substantially executed by the contractor.

The depth on the outer bar still remains shallow, there being about 7 feet at low tide and about 11½ feet at high tide.

EMPLOYÉS.

Mr. P. E. Twiggs remained inspector of the work at Brush Camp and North Island until January, when he resigned to take charge of the steamer *E. A. Twiggs*. He was succeeded by Mr. J. A. Dill, who was placed in charge of dike at South Island May 15, being relieved by Mr. H. Bryan. These gentlemen deserve credit for very energetic and careful work.

Very respectfully, your obedient servant,

CHAS. HUMPHREYS,
Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. Army.

COMMERCIAL STATISTICS.

The commerce for the year ending December 31, 1891, is estimated as follows:

Class of goods.	Exports.	Imports.	Totals.	Tonnage.
				Tons.
Cotton and products	$640, 000	....	$640, 000	3, 200
Rice	431, 000	....	431, 000	4, 858
Vegetables and truck	8, 000	....	8, 000	120
Live stock and products	750	....	750	5
Fish, oysters, etc	100, 000	....	100, 000	4, 000
Naval stores	1, 273, 750	....	1, 273, 750	63,178
Lumber and products	602, 000	....	602, 000	60, 925
General merchandise	1, 600, 000	$3, 400, 000	5, 000, 000	125, 000
Sundries	....	....	21, 000	84
Total	4, 671, 600	3, 400, 000	8, 071, 600	261, 370

Decrease over last year, $434,000; tons, 340.
Transportation lines established during year, none.
The decrease in commerce is due largely to the small cotton crops of this section.
The above statistics are based mainly upon reports of Assistant Engineer Charles Humphreys, made after much correspondence and conversation with steamboat captains and agents, custom-house officials, and prominent shippers and merchants.

Winyaw Bay, South Carolina.

APPROPRIATED.

Date.	Amount.	Aggregate.
August 5, 1886	$18, 750	$18, 750
August 11, 1888	100, 000	118, 750
September 19, 1890	100, 000	218, 750

EXPENDED.

Fiscal year ending June 30—	During year.	Aggregate.
1887	$2, 625. 42	$2, 625. 42
1888	1, 126. 30	3, 751. 72
1889	3, 228. 54	6, 980. 26
1890	13, 047. 19	20, 027. 45
1891	12, 809. 43	32, 836. 88

FREIGHT TRANSPORTED.

Fiscal year ending June 30—	Tons.	Value.
1886	125, 000	$4, 000, 000
1887	....	6, 990, 000
1888	....	7, 545, 000
1889	....	7, 899, 175
1890	196, 754	7, 919, 700
1891	261, 029	8, 505, 625

L 24.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The following is quoted from the last Annual Report (of June 30, 1891):

Schooner opposite Swan Point, Pamlico River.—In February, 1891, the people navigating Pamlico River made complaint that the old wreck of an old schooner had drifted into a position near the main channel of the Pamlico River below Washington, N. C., in such way as to endanger the navigation of that river.

Examination elicited the following information:

This schooner was a two-masted wooden vessel of about 90 feet length, 25 feet beam, 7 feet draft, and 90 tons burden, and was sunk about 1882 by running upon other wrecks then in the river. Immediately after sinking it was stripped of everything then deemed worth saving and was then abandoned. Since then it is reported to have several times shifted its position under the effect of storms, tides, and currents, and also to have been set on fire three years ago, burning to the water's edge.

Portions of the wreck rose to 1 foot above low water and other portions descended to 10 feet below low water.

The natural bottom was sand and mud, with accumulations of sand around the wreck to 3 to 5 feet depth on the bow and nothing at its stern.

There was supposed to be nothing about the wreck of any special value or specially worth saving.

By virtue of the provisions of the law of the 14th of June, 1880, and of section 8 of the river and harbor act of 19th of September, 1890, authority was granted in March, 1891, for the removal of this wreck, and $150 was allotted for that purpose.

Owing to its character and its small cost the removal of this wreck was allowably to be done by hired labor and the purchase of materials in open market, using the employés and plant belonging to the improvements of this and neighboring streams.

No work was done prior to the 30th of June, 1891, as it was thought best to wait until the Government plant should next pass that way.

In August, 1891, the wreck was blown up, shattered timbers and other débris floated away, and August 11, 1891, when the work was completed, soundings failed to show anything that could damage a passing vessel.

APPENDIX M.

IMPROVEMENT OF LUMBER AND WACCAMAW RIVERS, NORTH CAROLINA AND SOUTH CAROLINA, AND OF CERTAIN RIVERS AND HARBORS IN SOUTH CAROLINA.

REPORT OF CAPTAIN FREDERIC V. ABBOT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Waccamaw River, North and South Carolina.
2. Lumber River, North and South Carolina.
3. Little Pedee River, South Carolina.
4. Great Pedee River, South Carolina.
5. Clark River, South Carolina.
6. Mingo Creek, South Carolina.
7. Santee River, South Carolina.
8. Wateree River, South Carolina.
9. Congaree River, South Carolina.
10. Harbor at Charleston, South Carolina.
11. Ashley River, South Carolina.
12. Wappoo Cut, South Carolina.
13. Edisto River, South Carolina.
14. Salkahatchie River, South Carolina.
15. Beaufort River, South Carolina.
16. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 4, 1892.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1892, for the works of improvement of rivers and harbors which have been in my charge.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

M I.

IMPROVEMENT OF WACCAMAW RIVER, NORTH AND SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see page 848, Annual Report for 1880. For map of river see page 1200, Annual Report for 1889.

ORIGINAL CONDITION.

In 1880 this stream was navigable for 12-foot boats at all stages of water from Georgetown 23 miles to Bull Creek, and at high water 4 miles farther to Bucks Lower Mills; thence for 7-foot draft boats at high water 22 miles farther to Conway; thence it possessed an obstructed channel for 3-foot draft boats at ordinary winter water 68 miles to Reeves Ferry; thence an obstructed channel with 3 feet at high water for 30 miles to Lake Waccamaw.

PLAN OF IMPROVEMENT.

The project provides for a channel 12 feet deep at all stages of water, with 80 feet bottom width, from the mouth of the river to Conway; thence a cleared channel to Lake Waccamaw, at an estimated cost of $138,400.

WORK PRIOR TO JUNE 30, 1891.

At eight shoals jetties made of piles and plank were put in. The river had been snagged between points no miles and 117 miles above the mouth since June 30, 1884, 17,722 obstructions having been removed. Before June 30, 1884, the records are not detailed enough to give exact figures.

WORK OF PAST YEAR.

Work has been continued with a hoister and crew hired from Mr. Thomas W. Daggett, of Conway, S. C. The river has been quite thoroughly cleared for a width of 40 feet and depth of 3 feet at low water between points 31 miles and 103 miles above the mouth. The average cost of removing obstructions was $0.75 each. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has shown his usual ability in conducting the work.

REMARKS.

One new transportation line has been established on this river during the year.

With the balance of $0.00 on hand July 1, 1892, nothing can be done. During the year the freight passing over this stream has aggregated 83,103 tons.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Approved June 14, 1880	$15,000
Approved March 3, 1881	10,000
Passed August 2, 1882	4,400
Approved July 5, 1884	6,000
Approved August 5, 1886	15,000
Of August 11, 1888	15,000
Approved September 19, 1890	12,500
Total	77,900

Total expenditures, including June 30, 1892, $77,900.

Money statement.

July 1, 1891, balance unexpended	$4,199.54
June 30, 1892, amount expended during fiscal year	4,199.54
Amount appropriated by act approved July 13, 1892	10,000.00
Amount (estimated) required for completion of existing project	50,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Waccamaw River, North and South Carolina, for the fiscal year ending June 30, 1892.

Work was continued by steam hoister and crew hired from Mr. Thomas W. Daggett, and ceased September 10, 1891, owing to the exhaustion of funds. The following obstructions have been removed, quite thoroughly clearing a channel to an approximate width of 40 feet and depth of 3 feet at low water:

From the channel: Logs, 332; stumps, 152; large snags, 92; small snags 1 cord. From the banks: Trees cut, 1,074; brush cut, 7 cords. Work was carried on between points 31 and 103 miles above the mouth of the river. Of the total amount expended, six-tenths were used on the channel and four-tenths on banks. Each obstruction cost, approximately, 75 cents. Minor repairs were made to Big Needle Eye and Oat Bed jetties, requiring the driving of 165 piles in the former and 23 in the latter. The owners and captains of steamers continue to express themselves as being highly pleased with the work.

Mr. Daggett has shown his usual untiring zeal and energy in his efforts for the success of the improvement.

Recommendations.—It is respectfully recommended that work be carried on above Conway as it has been this year, and the channel below Conway be maintained, at least, at its present width and depth.

Commerce.—The following statement is made up from the best information that could be obtained from Mr. D. T. McNeil, Messrs. W. L. Buck & Co., and H. L. Buck, large lumber and shingle manufacturers on the river; also Capt. Thomas W. Daggett.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Outward freights.						
Rosin .... barrels..	76,000	13,300	$228,000	78,000	15,600	$156,000
Tar .... do....	557	56	1,114	407	81	814
Spirits turpentine .... do....	12,000	2,250	240,000	14,000	2,800	220,000
Turpentine, crude .... do....	6,000	840	15,000	4,000	600	8,000
Cotton .... bales..	5,500	1,875	275,000	5,000	1,250	175,000
Timber .... sticks..	9,547	14,326	40,980	10,640	19,152	53,200
Lumber .... feet..	8,800,000	18,333	132,000	9,000,000	15,000	117,000
Shingles	9,800,000	4,900	78,400	9,200,000	4,600	73,600
Rough rice .... bushels..	122,000	2,684	152,500	155,100	2,806	178,365
Rice, clean .... barrels..	12,000	1,950	195,000	15,508	2,714	271,390
Miscellaneous articles, tallow, eggs, wax, game, poultry, etc.	....	1,231	123,118	....	1,500	75,000
	....	61,245	1,481,112	....	66,103	1,328,369
Inward freights.						
General merchandise	....	15,000	750,000	....	17,000	850,000
Total	....	76,245	2,231,112	....	83,103	2,178,369

This shows a slight increase over last year in tonnage, but decrease in value, owing to unusually low prices prevailing in the markets, and would still indicate the trade on the river to be in a healthy condition. One new line of transportation has been

added. The commerce has been carried on by seagoing vessels of about 350 to 400 tons, and steamers of from 15 to 300 tons. Considerable commerce is carried on by pole boats of which no account whatever could be obtained.

Employés.—Much credit is due Mr. C. J. Banta, timekeeper, for his usual efficient and neat work. Mr. J. D. Mayo, master machinist, in charge of all United States machinery under this office, has been especially faithful and successful in the discharge of his duties, and he is recommended as an excellent machinist and a thoroughly good, reliable runner of marine machinery.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Georgetown, S. C., from January 1, 1888, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1888	352	124,155	2,818	2	479	14	1	81	8	355	124,715	2,840
1889	365	128,705	2,920	2	424	10	1	149	7	368	129,278	2,943
1890	385	165,785	3,150	6	1,346	42	1	106	6	392	167,237	3,198
1891	420	191,651	4,035	1	245	7	2	292	14	423	192,188	4,056

CLEARED.

Year.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1888	342	121,715	2,735	8	1,835	55	1	81	8	351	123,631	2,798
1889	357	126,965	2,856	6	1,494	45	1	149	7	364	128,608	2,908
1890	372	160,458	3,069	9	1,978	63	2	355	13	383	162,791	3,145
1891	384	164,562	3,986	9	2,719	69	1	149	7	394	167,420	4,062

Commerce, foreign and domestic.

Year.	Value of exports.	Value of imports.	Duties collected.
1888	$3,125,000	$2,750,000	$32.44
1889	3,265,000	2,975,000	....
1890	3,454,000	3,175,000	60.54
1891	3,291,407	6,895,000	11.64

Total commerce, 1888 .... $5,875,000
Total commerce, 1889 6,240,000
Total commerce, 1890 6,629,000
Total commerce, 1891 9,809,077

R. O. BUSH.

M 2.

IMPROVEMENT OF LUMBER RIVER, NORTH AND SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination, see page 1102, Annual Report for 1887. For map of river, see page 1198, Annual Report for 1890.

ORIGINAL CONDITION.

The river was obstructed by logs, snags, stumps, overhanging trees, and in places by sand bars. Long reaches were in fair condition. That portion of the river between Lumberton and the North Carolina line was crossed by five low bridges without draw spans, and one moderately high railroad bridge near Lumberton. In South Carolina the river was crossed by two bridges without draws.

PLAN OF IMPROVEMENT.

The project provides for improving the river for steamboats from its mouth to Lumberton, a distance of 70.8 miles, by snagging and clearing the banks, at an estimated cost of $35,000.

WORK PRIOR TO JUNE 30, 1891.

The parties operating the Fair Bluff and Ivy Bluff bridges had provided satisfactory draw spans. The bridges at Griffins and Mathews had been discontinued. The bridge at Phillips will be provided with a draw as soon as the county commissioners operating it can raise the necessary funds. The river was quite thoroughly cleared by plant owned and operated by the United States for a width of 40 feet and depth of 3 feet at low water between points no miles and 71 miles above the mouth, 6,199 obstructions having been removed.

WORK OF PAST YEAR.

The river was quite thoroughly cleared by plant owned and operated by the United States for a width of 40 feet and depth of 3 feet at low water between points no miles and 50 miles above the mouth. The average cost of removing obstructions was 50 cents each. For details of work done, reference is made to the appended report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability in directing and controlling the working parties and maintaining the efficiency of the plant.

REMARKS.

Two small steamers have run irregularly on this river during the year. During the year freights passing over this stream have aggregated 6,800 tons.

With the balance of $496.62 on hand July 1, 1892, snagging will be continued as far as the funds will admit, removing the worst obstructions first.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is the port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Of August 11, 1888	$5,000
Approved September 19, 1890	5,000
Total	10,000

Total expenditures, including June 30, 1892, $9,503.38.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's annual report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$4,356.94
June 30, 1892, amount expended during fiscal year	3,860.32
July 1, 1892, balance unexpended	496.62
July 1, 1892, outstanding liabilities	45.00
July 1, 1892, balance available	451.62
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,451.62
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Lumber River, North and South Carolina, for fiscal year ending June 30, 1892:

Snagging and clearing banks were continued, beginning at the mouth of the river, by United States hand hoister and hired labor, and ended March 12, 1892, the funds having been exhausted at a point 49½ miles above mouth. The following obstructions were removed, quite thoroughly clearing banks and channel to an approximate width of 40 feet and depth of 3 feet at low water:

From the channel: Logs, 821; stumps, 347; large snags, 847; small snags, 66 cords. From the banks: Trees cut, 4,386; brush cut, 145½ cords. Of the total amount expended, five-tenths were used on banks and five-tenths on channel. Each obstruction cost, approximately, 50 cents.

Remarks.—It is respectfully recommended that work be continued as heretofore. Much more will be required to place the river in proper condition for safe steamboat navigation.

Commerce.—Such statement as could be obtained is given below. It was collected by J. W. Harllee, overseer, who made special trips up and down the river under orders from this office, visiting the principal shipping points and soliciting information on the subject from the most prominent business men, among whom may be mentioned R. R. Barnes, J. M. Powell, J. D. Rogers, W. H. Butters, and J. C. Smith.

It is respectfully requested that the accompanying letter from Mr. W. H. Butters be printed in and form part of this report.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Timber .... sticks..	3,000	4,500	$12,600	5,000	6,000	$18,000
Fertilizers	......	100	2,000	......	200	4,000
General merchandise	......	500	25,000	......	600	30,000
Total	......	5,100	39,600	......	6,800	52,000

The commerce has been carried on by pole boats and timber rafts, as all the bridges over the river are not yet supplied with draw openings to admit of steamboat navigation, two of them having been so provided, namely, at Fair Bluff and Ivy Bluff, North Carolina. Last year the commerce on the river amounted to 5,100 tons; this year it amounts to 6,800 tons, showing an increase of 1,700 tons. The shipments to and from Lumberton, N. C., by railroad consist of about 1,500 barrels spirits turpentine, 7,000 barrels rosin, 6,000 bales cotton, 300 barrels tar, and 900 carloads of general merchandise. To and from Fair Bluff, another town on the river, the shipments are about the same by railroad as to Lumberton. To and from Nichols, the only other town near the river, distant about 1 mile, the shipments are about 2,700 bales cotton, 1,200 barrels spirits turpentine, 6,000 barrels rosin, and 2,900 tons general merchandise. The aggregate exports and imports by rail, according to the above, amount to 19,975 tons, valued at about $1,205,200, being approximately the same as last year.

The Messrs. Butters, of Michigan, have built and put in operation at Hub, on the river, one of the largest saw and shingle mills in the South. They have two small steamers in use for towing logs.

Employés.—Mr. B. T. Daggett, overseer, deserves credit for the efficient and economical manner of managing the field work. He has been well assisted by Mr. J. T. Haywood, suboverseer.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

LETTER OF MR. W. H. BUTTERS.

HUB, COLUMBUS COUNTY, N. C., *March 15, 1892.*

DEAR SIR: In regard to river improvement we would say that we think that this river should be improved so as to be made navigable from Lumberton to tidewater. Last year we bought and logged ourselves about 2,000,000 feet of pine above this place, which came down Lumber River. We are also now getting a large quantity of logs down this river, and have had 4,000 or 5,000 logs since January 1. If the river was navigable, so that steamers of light draft could reach this place, we think we could ship the greatest part of our lumber by water. We estimate that we will cut between 12,000,000 and 15,000,000 feet of cypress and pine lumber this year. Of course the steamers that carried this lumber would also have our supplies to bring back, which probably would amount to fully $100,000 for the year 1892. This, of course, would be quite a little freight. We hope the Government will make a good appropriation this year, as, if they only appropriated $5,000, same as they have done the last couple of years, it will be some time before steamers could reach us. We think that if the river was improved so as to be navigable, there is no doubt but that some steamship company would put on a regular line. Please let us know what you think the prospects are and oblige,

Yours truly,

W. H. BUTTERS.

Mr. REID WHITFORD.

M 3.

IMPROVEMENT OF LITTLE PEDEE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see page 1111, Annual Report for 1887.
For map of river see page 1214, Annual Report for 1890.

ORIGINAL CONDITION.

The river was much obstructed by snags and overhanging trees, and in places was divided into several branches, in neither of which there was a good channel, and by ten bridges without draws.

PLAN OF IMPROVEMENT.

It is proposed to snag the river and close unnecessary branches, providing for steamboat navigation up to the mouth of Lumber River and pole-boat navigation thence to Little Rock, at an estimated cost of $50,000.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points no miles and 113 miles above the mouth, 9,227 obstructions having been removed.

WORK OF PAST YEAR.

The river was quite thoroughly cleared by plant owned and operated by the United States, for a width of 40 feet and depth of 3 feet at low water between points 31 and 113 miles above the mouth. The average cost of removing obstructions was 42 cents each. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has showed marked ability in directing and controlling the working party and maintaining the efficiency of the plant.

REMARKS.

One new transportation line has been established on this river during the year, and a steamer has run somewhat irregularly part of the time.

With the balance of $307.12 on hand July 1, 1892, snagging will be continued, the worst obstructions being removed first. During the year the freight passing over this stream has aggregated 7,115 tons.

This river is tributry to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Of August 11, 1888	$5,000
Approved September 19, 1890	5,000
Total	10,000

Total expenditures, including June 30, 1892, $9,692.88.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's annual report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$2,861.59
June 30, 1892, amount expended during fiscal year	2,554.47
July 1, 1892, balance unexpended	307.12
July 1, 1892, outstanding liabilities	40.00
July 1, 1892, balance available	267.12
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,267.12
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Little Pedee River, South Carolina, for fiscal year ending June 30, 1892.

Snagging and clearing banks were continued by United States hoister and hired labor. The following obstructions have been removed, roughly clearing banks and channel to an approximate width of 40 feet and depth of 3 feet at low water: From the channel: Logs, 521; stumps, 185; large snags, 366; small snags, cords, 47½. From the banks: Trees cut, 1,252; brush cut, 91 cords. Work was carried on between points 112½ miles and 30½ miles above the mouth of the river. Of the total amount expended eight-tenths were used on the channel and two-tenths on the banks. Each obstruction cost approximately 42 cents.

Remarks.—The river has been very much improved by the United States work, as those running boats state. There is still much left to be done before the channel is thoroughly cleared of obstructions.

Recommendations.—It is respectfully recommended that the same character of work be continued till a thoroughly cleared channel be completed from its mouth to Little Rock, the head of navigation.

Commerce.—The following statement was made up from information given to Mr. J. W. Harllee, overseer, who, acting under orders from this office, visited the business men near the river, named below: J. T. Ritter, L. Brown, Ellerbee & Ellerbee, W. H. Breeden, B. F. Davis, and J. W. Holliday. The timber statement was furnished by J. W. Harllee, overseer, who kept account of the rafts as they passed down the river.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Outward freights.						
Rosin .... barrels..	3,920	686	$5,880	5,000	1,000	$10,000
Spirits turpentine .... do....	408	77	8,160	636	127	9,540
Cotton .... bales..	310	78	15,500	600	150	21,000
Ton timber .... sticks..	2,200	3,300	9,240	4,240	5,088	15,264
Shingles	30,000	15	240	20,000	10	160
Total	....	4,156	39,020	....	6,375	55,964
Inward freights.						
General merchandise	....	458	13,740	....	740	37,000
Grand total	....	4,614	52,760	....	7,115	92,964

This shows an increase of 2,501 tons over last year. The commerce has been carried on by one steamer of 80 tons, pole boats, and rafts. One new line of pole boats has been added, and the steamer has made extra trips.

Employés.—Mr. J. W. Harllee, overseer; S. M. Stevenson, engine driver, and J. P. Rumley, timekeeper, have been very faithful in the discharge of their duties.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 4.

IMPROVEMENT OF GREAT PEDEE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination, see page 753, Annual Report for 1873. For special description, see page 845, Annual Report for 1880, and page 723, Annual Report for 1879. For map of river, see page 1180, Annual Report for 1889.

ORIGINAL CONDITION.

The river was dangerously obstructed by snags and logs everywhere. Boats drawing 9 feet of water were able to reach Smith Mills, 52 miles above the mouth. Those drawing 3½ feet at low water could get 54 miles further up, to Little Bluff, or at high water to Cheraw, 172 miles from the mouth.

PLAN OF IMPROVEMENT.

The project provides for a thoroughly cleared 9-foot navigation to Smith Mills, and a 3½-foot navigation to Cheraw at all stages of water, at an estimated cost of $117,000.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points no miles and 172 miles above the mouth, since June 30, 1884, 15,996 obstructions having been removed. Before June 30, 1884, the records are not detailed enough to give exact figures.

WORK OF PAST YEAR.

The river was quite thoroughly cleared by plant owned and operated by the United States for a width of 80 feet and depth of 4 feet at low water between points 54 miles and 172 miles above the mouth. The average cost of removing obstructions was $1.05 each.

For details of work done and commercial statistics, reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability in directing and controlling the working party and maintaining the efficiency of the plant. Parties operating Society Hill Bridge were notified to put in proper fenders by September 1, 1892. They have taken no steps to do so.

REMARKS.

One new transportation line has been established on this river during the year. With the balance of $3,857.39 on hand July 1, 1892, snagging will be continued, the worst obstructions being removed first. During the year the freight passing over this stream has aggregated 92,471 tons.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Approved June 14, 1880	$7,000
Approved March 3, 1881	6,000
Passed August 2, 1882	6,000
Approved July 5, 1884	8,000
Approved August 5, 1886	20,000
Of August 11, 1888	20,000
Approved September 19, 1890	12,500
Total	79,500

Total expenditures, including June 30, 1892, $75,642.61.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's Annual Report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$9,460.98
June 30, 1892, amount expended during fiscal year	5,603.59
July 1, 1892, balance unexpended	3,857.39
July 1, 1892, outstanding liabilities	610.32
July 1, 1892, balance available	3,247.07
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	13,247.07
Amount (estimated) required for completion of existing project	27,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	27,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Great Pee Dee River, South Carolina, for fiscal year ending June 30, 1892:

Snagging and clearing banks continued by United States steam hoister and hired labor. The following obstructions have been removed, roughly clearing banks and channel to an approximate width of 80 feet and depth of 3 feet at low water. From the channel: Logs, 988; stumps, 185; large snags, 475; small snags, 10 cords. From the banks: Trees cut, 1,680; brush cut, 51 cords. Work has been carried on between points 54 miles and 172 miles above the mouth of river. Of the total amount expended six-tenths were used on the channel and four-tenths were used on the banks. Each obstruction cost, approximately, $1.05; cost increased by high water.

The progress of the work was greatly delayed by unusually high freshets during the year.

Remarks.—The improvement of the river by the United States work has been decided, as captains of river steamers and others in a position to know, freely state.

Recommendations.—It is respectfully recommended that the same character of work be carried on till a thoroughly cleared channel be completed from the mouth of the river to Cheraw.

Commerce.—The following statement was obtained by Mr. J. C. Tamplet, timekeeper, who, acting under orders from this office, visited all the principal shipping and receiving places on the river, and from them collected the figures given. Among the business men who gave this information may be mentioned E. P. Smith, L. F. Davis, W. L. Buck & Co., and B. A. Munnerlyn, agent South Carolina steamboats.

	1891.			1892.		
	Number.	Tons.	Value.	Number.	Tons.	Value.
Outward freights.						
Cotton ... bales	5,926	1,483	$296,300	5,780	1,445	$202,300
Clean rice ... barrels	16,342	2,656	265,558	16,560	2,898	289,750
Rough rice ... bushels	83,000	1,827	103,750	88,000	1,524	101,200
Rosin ... barrels	35,800	6,265	50,120	30,000	6,000	60,000
Spirits turpentine ... do	4,014	652	80,280	5,436	1,087	81,540
Cypress shingles	6,705,987	3,353	53,640	6,970,000	3,485	55,760
Lumber, cypress ... feet	3,000,000	6,250	45,000	3,100,000	5,166	46,500
Cypress logs ... do	22,547	33,821	81,169	...	...	...
Wood ... cords	225	225	563	2,000	2,000	4,000
Hides, wool, staves, etc	...	250	7,500	352	352	17,600
Timber ... sticks	...	...	...	51,640	61,968	216,888
Cross ties	...	...	...	18,000	144	5,400
Total	...	56,782	983,880	...	86,069	1,080,938
Inward freights.						
General merchandise	...	5,562	383,450	...	6,402	320,100
Grand total	...	62,344	1,367,330	...	92,471	1,401,038

This shows an increase of approximately 30,127 tons over that given in 1891. Commerce has been carried on by seagoing schooners of 250 to 300 tons, and tugboats to Port Harrelson and Smith Mills, and the steamers *Santee*, *Merchant*, *John M. Cole*, to Cheraw, the head of navigation.

There has been one new steamboat line of transportation established.

Employés.—Mr. Homer Jacobs, overseer; Mr. John R. Smith, engine-driver; and Mr. J. C. Tamplet, timekeeper, deserve credit for faithful and efficient services.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 5.

IMPROVEMENT OF CLARK RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination, see page 1109 Annual Report for 1887. For map of river, see page 1204 Annual Report for 1890.

ORIGINAL CONDITION.

This creek is really the southern mouth of Lynch River. Its upper end was entirely choked by a tangled mass of driftwood and fallen trees. The lower part was fairly clear of obstructions.

PLAN OF IMPROVEMENT.

The project provides for closing the northern mouth of Lynch River and thoroughly snagging Clark Creek, at an estimated cost of $7,500.

WORK PRIOR TO JUNE 30, 1891.

The first 3 miles from the mouth was quite thoroughly cleared of obstructions for a width of 40 feet and depth of 3 feet at low water. The remaining three-fourths of a mile was roughly worked over. The last 590 feet next to Lynch River being solidly packed with logs for the entire width of the stream, a passage 25 feet wide was all that could be provided with the money on hand, and this was so shoal that it could only be used during freshets. One thousand and seventy-four obstructions, consisting of logs, snags, etc., were taken from the channel, and 230 overhanging trees, etc., were cut from the banks. A survey of the creek was made.

WORK OF THE PAST YEAR.

The creek was roughly cleared by plant owned and operated by the United States, for a width of 40 feet and depth of 3 feet at low water, between points no miles and 7 miles above the mouth. The average cost of removing obstructions was 42 cents each. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has showed marked ability

in directing and controlling the working party, and maintaining the efficiency of the plant.

REMARKS.

One new transportation line has been established on this river during the year.

With the balance of $0.00 on hand July 1, 1892, nothing can be done. During the year the freight passing over this stream has aggregated 6,586 tons.

This creek is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Of August 11, 1888	$2,500
Approved September 19, 1890	2,500
Total	5,000

Total expenditures, including June 30, 1892, $5,000.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's Annual Report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$2,261.68
June 30, 1892, amount expended during fiscal year	2,261.68
Amount appropriated by act approved July 13, 1892	2,500.00

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report relative to Clark Creek, South Carolina, for fiscal year ending June 30, 1892.

Operations began November 1, 1891, and continued till February 29, 1892. Funds having been exhausted, work ceased which had been done by United States steam hoister and hired labor. A channel 40 feet wide and 3 feet deep at ordinary low water was completed over the entire 6¾ miles of the creek from Great Pedee to Lynch River. The following obstructions were removed:

From the channel: Logs, 2,778; stumps, 100; large snags, 1,468; small snags, 394 cords. From the banks: 553 trees cut; 43 cords brush cut. Each obstruction cost approximately 42 cents. Of the amount expended nine-tenths were used on the channel and one-tenth on banks.

Remarks.—The creek when once fairly opened will be of great convenience to the people living on Lynch River, of which Clark Creek is the best outlet into the Great Pedee River. There is much valuable timber and fertile, well-cultivated land along Clark Creek and Lynch River. Immediately after the above channel was opened it began to be used and the commerce given below was at once developed.

Recommendations.—It is respectfully recommended that the work of snagging and clearing banks be continued till an unobstructed channel-way be provided. In addition to this a timber dam be built across Lynch River to keep out the drift which enters that river from the Great Pedee during freshets.

Commerce.—The following statement was collected by R. G. Dusenbury, overseer, who visited the business men in person, among whom may be mentioned J. G. Eaddy & Co. and W. L. Buck & Co.:

	No.	Tons.	Value.
Outward freights.			
Rosin ....barrels..	5,000	1,000	$10,000
Timber ....sticks..	4,447	5,336	16,009
	....	6,336	26,009
Inward freights.			
Fertilizers	....	250	2,000
Total........	....	6,586	28,009

The commerce last year was nothing. This year, because of the improvement of the creek, an increase of 6,586 tons are shown. It was carried on by pole boats and rafts.

Employés.—There is no better place than this to say that Mr. William Alden James, clerk, deserves special mention for his most efficient and valuable assistance in the efforts made to carry out your orders concerning all works in local charge of this office, and R. G. Dusenbury, overseer, did excellent work in removing the obstructions from the creek.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 6.

IMPROVEMENT OF MINGO CREEK, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see page 1106, Annual Report for 1887.
For map of river see page 1202, Annual Report for 1890.

ORIGINAL CONDITION.

The creek was much obstructed by snags and overhanging trees, and was crossed by one bridge without a draw.

PLAN OF IMPROVEMENT.

The project provides for improving the creek for steamboats from its mouth to Williams Landing, and for pole boats at high water up to the head of navigation, by snagging and clearing the banks, at an estimated cost of $17,000.

WORK PRIOR TO JUNE 30, 1891.

The creek was snagged between points 13 miles and no miles above the mouth, 7,967 obstructions having been removed. The parties operating the Mingo Bridge had put in a draw span.

WORK OF PAST YEAR.

The creek was quite thoroughly cleared by plant owned and operated by the United States, for a width of 40 feet and depth of 4 feet at low water, between points no miles and 15 miles above the mouth. The average cost of removing obstructions was $0.31 each. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability in directing and controlling the working party, and maintaining the efficiency of the plant.

REMARKS.

One new transportation line has been established on this creek during the year.

With the balance of $515.13 on hand July 1, 1892, snagging will be continued, the worst obstructions being removed first. During the year the freight passing over this stream has aggregated 55,280 tons.

This creek is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of—	
Congress of August 11, 1888	$5,000
Congress approved September 19, 1890	5,000
Total	10,000

Total expenditures, including June 30, 1892, $9,484.87.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's annual report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$3,077.67
June 30, 1892, amount expended during fiscal year	2,562.54
July 1, 1892, balance unexpended	515.13
July 1, 1892, outstanding liabilities	69.00
July 1, 1892, balance available	446.13
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,446.13
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Mingo Creek, South Carolina, for fiscal year ending June 30, 1892:

Snagging and clearing banks were continued by United States hand hoister and hired labor, and was suspended November 30, 1891, because of the exhaustion of funds. The following obstructions have been removed, quite thoroughly clearing

the banks and channel to an approximate width of 40 feet and depth of 4 feet at low water. From the channel: Logs, 248; stumps, 87; large snags, 87; small snags, 10 cords. From the banks: Trees cut, 2,632; brush cut, 378 cords. The work was carried on between points no miles and 15 miles above the mouth of the creek. Of the total amount expended four-tenths were used on the channel and six-tenths on the banks. Each obstruction cost, approximately, 31 cents.

Remarks.—The improvement made in the navigation of the creek has been very great, and those in a position to know so freely state.

Recommendations.—It is respectfully recommended that the same character of work be carried on till a thoroughly cleared channel be completed.

Commerce.—The accompanying letter and statement from Messrs. F. Rhem & Sons on this subject explain themselves. The above-mentioned firm controls a large portion of the commerce on the creek, and are in a position to know about the value of the exports and imports. The commerce has been carried on by two steamers of 100 and 20 tons and a number of pole boats, rafts, etc. Total freights carried have increased by about 12,405 tons over last year. There has been one new line of transportation established.

Employés.—Mr. F. A. Haddock, overseer, and Mr. J. D. Sturgeon, timekeeper, have shown their usual zeal and efficiency in the discharge of their duties.

COMMERCIAL STATISTICS.

RHEMS, S. C., *January* 1, 1892.

SIR: We give below a statement of Mingo River, South Carolina, from May 1, 1891, to January 1, 1892, showing the exports and imports. You will observe that this report is only for eight months while last it was for twelve months, still the recent improvement has steadily increased the exports and imports. There has been remarkable improvement made on the lower part of the river and some improvement above Mingo Bridge, which improvement we feel satisfied would still further the interest of commerce and enhance property along the banks of said river. We have watched the work of Mr. F. A. Haddock and his assistant, and must compliment them on their good work and judgment since May, 1891.

Yours, very respectfully,

F. RHEM & SONS.

Mr. REID WHITFORD,
U. S. Assistant Engineer.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Exports.						
Spirits turpentine ....barrels..	11,000	2,750	$220,000	12,000	8,000	$192,000
Rosin ....do....	66,000	11,550	145,000	70,000	14,000	175,000
Crude turpentine........do....	5,000	1,000	25,000	5,000	1,000	20,000
Wood ....cords..	6,000	6,000	15,000	10,000	10,000	30,000
Staves	350,000	700	1,400	750,000	1,750	3,500
Hoop poles	50,000	50	5,000	50,000	50	6,000
Cotton........bales..	4,500	1,125	202,500	7,000	1,750	245,000
Shingles	600,000	300	5,000	200,000	30	1,400
Other produce, including wool........	....	400	20,000	....	450	25,000
Lumber, cross-ties, etc	....	12,000	60,000	....	15,000	75,000
	....	35,875	698,900	....	47,030	772,900
Imports.						
General merchandise	....	7,000	350,000	....	8,250	412,500
Total	....	42,875	1,048,900	....	55,280	1,185,400

Excess of exports, 1890, $348,900; 1891, $360,400.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 7.

IMPROVEMENT OF SANTEE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For description of river see page 916, Annual Report for 1880. For new project see page 1184, Annual Report for 1889. For map of river see page 1186, Annual Report for 1889.

ORIGINAL CONDITION.

This river was considerably obstructed at all stages of water by sunken logs and snags. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet of water at low tide. Four steamers and a few small vessels were then running upon portions of the river.

PLAN OF IMPROVEMENT.

The project of 1880 proposed to provide the river with a good outlet through Mosquito Creek to Winyaw Bay, by deepening and straightening this creek to 50 feet width and 7 feet depth; to secure 7-foot navigation in the river from its mouth 120 miles to Wright Bluff, and thence 5-foot navigation 23 miles farther, to the head in the Congaree and Wateree rivers.

The revised project of 1889 provides for leaving the Mosquito Creek Canal, which has been completed 30 feet wide and 3 feet deep, for a timber route; cutting a new canal between Estherville and Minim Creek large enough for river steamers, and snagging the entire river, at an estimated cost of $350,000.

WORK PRIOR TO JUNE 30, 1891.

A passage 30 feet wide and 3 feet deep at high water through Mosquito Creek to Winyaw Bay had been made; the excavation amounted to 206,515 cubic yards.

The river had been snagged between points 41 miles and 42 miles above the mouth, 285 obstructions having been removed.

Dredging on the new cut between Estherville and Minim Creek had begun.

Work on the flood gate in the old Mosquito Creek Canal had been nearly completed.

WORK OF PAST YEAR.

Dredging on the new cut between Estherville and Minim Creek under contract with Mr. Louis S. Ehrich, of Georgetown, S. C., continued.

After many delays his contract was annulled on May 1, 1892. A dredge was rented by the United States, and dredging was continued by hired labor.

Work on the flood gate in the old Mosquito Creek Canal was completed.

For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability and zeal in conducting the work.

REMARKS.

One new transportation line has been established on this river during the year.

With the balance of $16,409.49 on hand July 1, 1892, dredging will be continued upon the Estherville-Minim Creek route, and some further snagging may be done on the river proper, if it shall seem to be required by the best interests of navigation.

During the year the freight passing over this stream has aggregated 110,523 tons.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Approved March 3, 1881	$22,000
Passed August 3, 1882	20,000
Approved July 15, 1884	15,000
Approved August 5, 1886	18,750
Of August 11, 1888	24,000
Approved September 19, 1890	30,000
Total	129,750

Total expenditures, including June 30, 1892, $113,340.51.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's annual report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$26,890.88
June 30, 1892, amount expended during fiscal year	10,481.39
July 1, 1892, balance unexpended	16,409.49
July 1, 1892, outstanding liabilities	1,115.02
July 1, 1892, balance available	15,294.47
Amount appropriated by act approved July 13, 1892	30,000.00
Amount available for fiscal year ending June 30, 1893	45,294.47
Amount (estimated) required for completion of existing project	290,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Santee River, South Carolina, for fiscal year ending June 30, 1892:

No snagging has been done on the river. Dredging was continued by Mr. Louis S. Ehrich, under his contract in dredging the Estherville-Minim Creek Canal. Up to the 1st day of May he had removed a total of 12,776 cubic yards, at which date the time of his contract having expired, and failing to get it renewed, it was annulled, after which his plant was rented by the United States, who proceeded to do the work by hired labor. By this method there has been removed 1,169 cubic yards. Mr. Wm. C. Johnstone finished the restoration of his rice-field drainage so far as demanded from the present appropriation. This embraced a total of 1,810

linear feet—3,700 feet having been finished last year. These amounts complete the amount (5,510 feet) under Mr. Johnstone's agreement. Mr. Henry E. Eaddy completed the Mosquito Creek floodgate in a very satisfactory manner.

Recommendations.—It is respectfully recommended that no more snagging be done on the Santee with the present appropriation unless specially requested by the steamboat managers, that the work be carried on as rapidly as possible on the new canal line; that the old route at Mosquito Creek be put in somewhat better condition than it is now, and so maintained till at least the new route is ready for use by the public. This will probably require the expenditure of about $5,000 out of each appropriation.

Commerce.—The accompanying statement of commerce is furnished by Mr. L. S. Ehrich, president of the Georgetown Board of Trade. Mr. Ehrich says he takes great care to have it as correct as it is possible to get it. He has given the statistics for this river his personal attention for several years past, and he is in a position, being engaged in large cross-tie and lumber business on the Santee River, to know more about the commerce than anyone in this place. The total freights carried show an increase of about 10,268 tons. There has been one new line of transportation established, a steamer running from Georgetown, through Mosquito Creek Canal, to landings on the Santee River. The other steamers have run with their usual regularity. Large quantities of valuable cypress timber have come through the United States canal at Mosquito Creek.

Employés.—I am much indebted to Mr. H. F. Price, surveyor and inspector, for his usual most excellent, efficient, and faithful work.

LETTER FROM MR. L. S. EHRICH, CHAIRMAN GEORGETOWN BOARD OF TRADE.

PALMETTO CYPRESS COMPANY, *May 26, 1892.*

DEAR SIR: I beg to submit herewith a report of statistics as to Santee River, in accordance with your request. I have given this matter some time and am certain this estimate of the commerce of the river is as near correct as it is practicable to get same. The principal change in outward products is in the item of timber, which is still in its infancy, as far as quantity shipped is concerned, and will increase each year the more rapid when the United States Government shall have completed the present project of a canal connecting Winyah Bay with Santee River, via Minim Creek Canal. The increased value of the swamp lands along the Santee River since the completion of the first Government improvement, namely, the cutting of Mosquito Creek Canal, is tenfold more than the amount expended by the Government, and has had the effect of bringing capital to this State for the purpose of manufacturing the products of these swamp lands, and will, as soon as the work now going on at our bar shall have given us deeper water, make Georgetown one of the (if not the) largest shipping ports, so far as lumber goes, on the Atlantic coast. The Western firm which I alluded to in my last letter have since erected their plant and are now at work and calculate to ship at least 30,000,000 feet per year. Other firms are now prospecting and will locate either in Georgetown or at some point on the Santee River.

The other items of commerce on the river are subject to great extent on the seasons, the past one having been favorable. The steamers plying the river have done a large business and the number will be increased this year.

Very respectfully,

L. S. EHRICH,
President Georgetown Board of Trade.

REID WHITFORD, Esq.,
U. S. Assistant Engineer.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Outward.						
Cotton.......................bales..	20,000	5,000	$350,000	22,000	5,500	$800,000
Rosin........................barrels..	140,000	24,500	175,000	150,000	30,000	185,000
Spirits ....do....	25,000	4,687	350,000	26,000	5,100	355,000
Timber ....pieces..	12,000	18,000	60,000	21,000	25,200	90,000
Shingles	3,000,000	1,500	15,000	3,500,000	1,750	17,500
Lumber.........................feet..	2,000,000	3,333	20,000	2,000,000	2,000	20,000
Railroad ties	23,000	1,610	6,900	35,000	2,800	10,500
Wool.......................pounds..	50,000	25	15,000	50,000	25	12,500
Hides ....,......................do....	15,000	8	1,500	20,000	10	1,600
Seed oats...................bushels..	7,000	210	4,200	8,000	184	4,800
Rice............................do....	100,000	2,200	150,000	140,000	3,220	175,000
Staves................................	500,000	500	2,500	400,000	1,000	2,200
Wood ....cords..	10,000	10.000	12,000	12,000	12,000	15,000
Game and fish	....	15	1,500	....	34	1,700
	....	71,588	1,663,600	....	88,823	1,690,800
Inward.						
Fertilizers	....	*7,500	225,000	....	4,600	230,000
Groceries, provisions, etc	....	*11,667	350,000	....	6,600	330,000
Dry goods	....	*4,000	225,000	....	4,500	225,000
Boots, shoes, etc........................	....	*4,000	200,000	....	4,000	200,000
Hardware, implements, machinery...	....	*1,500	80,000	....	2,000	100,000
Total	....	100,255	2,743,600	....	110,523	2,775,800

* Value of these tons is necessarily estimated.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 8.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination, see page 914, Annual Report for 1880. For map of river, see page 1190, Annual Report for 1889.

ORIGINAL CONDITION.

In 1882 this stream had a low-water depth of from 3 to 4 feet from its mouth, 68 miles, to Camden. The lower 14 miles was completely blocked at all stages of water by logs, snags, etc., and at moderate stages by the bridges of the South Carolina and the Wilmington, Columbia, and Augusta Railroads, then without draw spans; thence to Camden, navigation was possible, but dangerous, except during high water. Its commerce was practically nothing.

PLAN OF IMPROVEMENT.

The project provides for safe and unobstructed 4-foot navigation for steamers from Camden to the mouth at an estimated cost of $60,000.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points 68 miles and no miles above the mouth, since 1884 11,299 obstructions having been removed.

Previous to June 30, 1884, the records are not sufficiently detailed to give exact figures, but a very considerable amount of work had been done on the river. The railroad bridges had been provided with draws.

WORK OF PAST YEAR.

The river was quite thoroughly cleared, by plant owned and operated by the United States, for a width of 80 feet and depth of 4 feet at low water between points no miles and 67 miles above the mouth. The average cost of removing obstructions was 87 cents each. For details of work done and commercial statistics, reference is made to the appended report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability in directing and controlling the working parties and maintaining the efficiency of the plant.

REMARKS.

No new transportation lines have been established on the river during the year. The appropriation of September 19, 1890, completes the amount that this improvement was estimated to cost. By the expenditure of this sum the entire portion of the river covered by the project has been put into good condition for steamboat navigation. For its maintenance the snag boat owned by the river should be kept at work continuously. The stream is well worth this expense, which would amount to about $6,500 a year. If appropriations are made every two years, $13,000 could be advantageously spent in that period.

With the balance of $6,822.77 on hand July 1, 1892, snagging will be continued, the worst obstructions being removed first.

During the year the freight passing over this stream has aggregated 2,244 tons.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress:	
Approved March 3, 1881	$8,000
Passed August 2, 1882	15,000
Approved July 5, 1884	5,000
Approved August 5, 1886	7,500
Of August 11, 1888	12,000
Approved September 19, 1890	12,500
Total	60,000

Total expenditures, including June 30, 1892, $53,177.23.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's Annual Report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$13,640.39
June 30, 1892, amount expended during fiscal year	6,817.62
July 1, 1892, balance unexpended	6,822.77
July 1, 1892, outstanding liabilities	462.64
July 1, 1892, balance available	6,360.13
Amount appropriated by act approved July 13, 1892	2,500.00
Amount available for fiscal year ending June 30, 1893	8,860.13
Amount that can be profitably expended in fiscal year ending June 30, 1894 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	6,500.00

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Wateree River, South Carolina., for fiscal year ending June 30, 1892.

Snagging and clearing banks were continued by United States steam hoister and hired labor. The following obstructions have been removed, roughly clearing the banks and channel to an approximate width of 80 feet and depth of 4 feet at low water:

From the channel: Logs, 571; stumps, 238; large snags, 931; small snags, 40 cords. From the banks: Trees cut, 1,806; brush cut 29 cords. Work has been carried on between points no miles and 67 miles above the mouth of the river. Of the total amount expended six-tenths were used on the channel and four-tenths on the banks. Each obstruction cost approximately 87 cents.

Remarks.—The progress of work was greatly delayed by continuous high freshets during the spring and winter. The work so far accomplished has been of marked benefit to the navigation of the river, as captains of the steamers state.

Recommendations.—It is respectfully recommended that work of a similar character be carried on till a thoroughly cleared channel from the mouth of the river to Camden be completed. After this has been done there will be required about $6,000 per year, or $12,000 from one appropriation to the other as they are at present made by Congress to keep the channel open, owing to the large quantities of drift coming down the river, lodging and forming obstructive jams. In addition, erosion of the banks during freshets causes much of the standing timber to fall in.

Commerce.—The following statement was obtained by Mr. E. C. Easterling, timekeeper, who, acting under orders from this office, visited all the principal shipping and receiving places along the river, and from them collected the figures given. The following letter from Mr. Easterling explains itself:

UNITED STATES HOISTER WATEREE,
May 24, 1892.

SIR: I have the honor to transmit a statement showing the outward and inward freights on the Wateree River, South Carolina, from May 1, 1891, to May 1, 1892.

Steamboat transportation has steadily gained favor with the planters along the river on account of its cheapness, compared with railroad transportation and its convenience. In many instances fertilizers are delivered in the fields by the boat which does away with many miles of hauling, on the west side of the river, the planters by patronizing the boat obviate the necessity of hauling across the toll bridge near Camden, the toll in some cases amounting to a considerable amount. For instance, one planter told me that in shipping his crop and receiving his fertilizers he paid over $100 a month toll, and that since he has been patronizing the steamboat his toll never amounts to over $8 per month. In the matter of freight a planter told me that in shipping 240 bales of cotton he saved in freight alone $100 by shipping by steamboat. Other instances of convenience and pecuniary saving could be cited.

The steamer running this river, during the busiest of the cotton season last fall, was taken off and sent to the Pedee, and when she returned made no regular trips, which was a great drawback to the commerce of the river.

Respectfully submitted.

E. C. EASTERLING,
Timekeeper.

MR. REID WHITFORD,
U. S. Assistant Engineer.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Outward freights.						
Cotton....bales..	415	104	$20,750	617	154	$21,600
Cotton-seed oil....barrels..	270	54	3,780	395	91	4,345
Cotton-seed meal....	....	27½	605	135	135	2,700
Cotton-seed hulls....	....	10	25	....	15	45
Cotton seed....bushels..	1,000	15	300	....	200	2,200
Rosin....barrels..	1,000	175	1,250	3,500	700	7,000
Rough rice....bushels..	10,000	220	12,500	7,000	161	8,750
	....	....	39,210	....	....	46,640
Inward freights.						
General merchandise....	....	400	12,000	....	788	39,400
Total....	....	1,005½	51,210	....	2,244	86,040

Last year there were 1,005¼ tons of commerce on the river. This year there are 2,244 tons, showing an increase of 1,239 tons. During the year the South Carolina Steamboat Company had a line of steamers running of from 250 to 300 tons burden, but they have not been operated with sufficient regularity to carry freights with as quick dispatch as the shippers seem to require, so it has been reported. The commerce is fast growing in importance. The river runs through the most fertile farming lands in the State.

Employés.—Capt. Kilbia Morse, overseer, Mr. E. C. Easterling, timekeeper, and Mr. B. H. Oliver, engine-driver, have as usual been very faithful and efficient in the discharge of their duties.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 9.

IMPROVEMENT OF CONGAREE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see page 1140, Annual Report for 1885. For map of river see page 1194, Annual Report for 1889.

ORIGINAL CONDITION.

In 1886 this stream had a low-water depth of 3 to 4 feet from its mouth to the railroad bridge at Columbia; thence 1 foot low-water depth 2 miles farther to its head. Navigation of the lower 47 miles was blocked at all stages of water by the South Carolina Railroad Bridge and by sunken logs, snags, and overhanging trees. The navigation of the remaining 2 miles was prevented by swift currents and numerous rock ledges and bowlders. Its commerce was nothing.

PLAN OF IMPROVEMENT.

The project proposes to secure a thoroughly cleared 4-foot navigation over the lower 47 miles at all stages and a cleared channel 100 feet wide through the shoals above, at an estimated cost of $54,500.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points no miles and 47 miles above the mouth, 4,768 obstructions having been removed. The railroad bridge had been provided with a draw.

WORK OF PAST YEAR.

The river was quite thoroughly cleared by a plant owned and operated by the United States for a width of 80 feet and a depth of 3 feet at low water between points no miles and 40 miles above the mouth. The average cost of removing obstructions was $0.89 each. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. Reid Whitford, who has shown marked ability in directing and controlling the working party and maintaining the efficiency of the plant.

REMARKS.

No new transportation lines have been established on the river during the year. With the balance of $0.00 on hand July 1, 1892, nothing can be done. During the year the freight passing over this stream has aggregated 3,686 tons.

This river is tributary to the collection district of Georgetown, S. C. Georgetown is its port of entry. Amount of duties collected in the calendar year of 1891, $11.64.

For this improvement the following appropriations have been made:

By act of Congress—	
Approved August 5, 1886	$7,500
Of August 11, 1888	7,500
Approved September 19, 1890	5,000
Total	20,000

Total expenditures, including June 30, 1892, $20,000.

For table of commercial statistics furnished by the collector of Georgetown, S. C., see this year's report for Waccamaw River.

Money statement.

July 1, 1891, balance unexpended	$2,575.19
June 30, 1892, amount expended during fiscal year	2,575.19
Amount appropriated by act approved July 13, 1892	5,000.00
Amount (estimated) required for completion of existing project	29,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1892.

CAPTAIN: I have the honor to make the following report of operations on Congaree River, South Carolina, for fiscal year ending June 30, 1892:

Snagging and clearing banks were continued by United States steam hoister and hired labor, and suspended July 31, 1891, because of the exhaustion of funds. The following obstructions have been removed, roughly clearing the banks and channel, to an approximate width of 80 feet and depth of 3 feet at low water:

From the channel: Logs, 116; stumps, 22; large snags, 65; small snags, 11 cords; from the banks, trees cut, 5.

Work has been carried on between points no miles and 40 miles above the mouth of the river. Of the total amount expended, nine-tenths were used on the channel and one-tenth on the banks. Each obstruction cost approximately 89 cents.

Remarks.—The progress of work was greatly delayed by continuous high freshets during the year. The work so far done has been of marked benefit to the navigation of the river, as the captains of the river steamers state.

Recommendations.—It is respectfully recommended that similar work be carried on till a thoroughly cleared channel be completed from the mouth of the river to Granby Landing, near Columbia; afterward to maintain the channel as completed.

The following statement, in the main, was obtained by Mr. R. G. Dusenbury, overseer, who, acting under orders from this office, visited all the shipping and receiving places along the river and from them collected the figures given.

The following letter to Mr. Dusenbury explains itself:

COLUMBIA, S. C., *May 26, 1892.*

DEAR SIR: The work done by the Government on the Congaree River as far as Granby has been of great benefit to Columbia so far, and if completed to this city would open up water transportation, and thus enable our merchants to compete with points around us, which is impossible under the present state of affairs.

As chairman of the Board of Trade of Columbia, I am now in correspondence with the Hon. G. W. Shell, Congressman from this district. He promises his influence in obtaining an appropriation from the Government as will be sufficient to complete the work from Granby to Columbia.

In your statistical report of the commerce of Congaree River I would be glad to have you touch upon this matter, which not only affects the city of Columbia, but this entire section of the State.

Very respectfully, yours,

W. J. MURRAY,
President Columbia Board of Trade.

Mr. R. G. DUSENBURY,
Overseer.

	1891.			1892.		
	No.	Tons.	Value.	No.	Tons.	Value.
Outward freights.						
Cotton ....bales..	100	25	$5,000	150	38	$5,250
Spirits turpentine ....barrels..	218	41	4,360	303	30	7,575
Rosin ....do....	8,200	1,435	11,480	10,975	2,743	16,450
Cotton seed	....	....	....	....	275	2,750
	....	1,501	20,840	....	3,086	32,025
Inward freights.						
General merchandise	....	900	27,000	....	600	30,000
Total	....	2,401	47,840	....	3,686	62,025

This shows an increase of 1,285 tons over the last year.

There is considerable commerce, consisting of saw logs, shingles, etc., of which no account and no estimate could be formed. This river is the city of Columbia's water outlet to the ocean. There have been no new transportation lines established, but a steamer of greater carrying capacity—200 to 300 tons—has been run. The Congaree flows through an exceedingly fertile country, and a large and important commerce will, by proper managment, flourish on it.

Employés.—Mr. R. G. Dusenbury, overseer, and Mr. J. E. Norman, engine-driver, deserve credit for efficient and faithful work.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

M 10.

IMPROVEMENT OF HARBOR AT CHARLESTON, INCLUDING SULLIVAN ISLAND AND MOUNT PLEASANT SHORE, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For history of operations up to June 30, 1888, see page 970, Annual Report for 1888. For modified project, including estimates, see page 1150, Annual Report for 1889.

ORIGINAL CONDITION.

There were four channels across the bar, the deepest having about 12 feet at low water.

PLAN OF IMPROVEMENT.

It is proposed to establish and maintain, by means of two jetties, a low-water channel of not less than 21 feet across the bar. The action

of the jetties is to be assisted by dredging. The estimated cost of the project is $4,380,500, if the jetties are left at mean low-water level throughout. If brought up to 3 feet above mean low-water level throughout, $5,334,500.

WORK PRIOR TO JUNE 30, 1891.

The foundations of both jetties had been completed out to the crest of the bar. Log mattresses loaded with stone were used throughout as foundation and to some extent as hearting. Considerable portions of both jetties had been raised to mean low water, and half a mile of the North Jetty to high water.

The following material had been used:

	Stone.		Mattresses.
	Tons.	*Cu. yds.*	*Sq. yds.*
North Jetty	48,144	122,335	175,155
South Jetty	89,553	143,414	306,585
Total	137,697	265,749	481,740

A plant for quarrying and depositing stone and a fine pump dredge had been procured for work by hired labor, in addition to that by contract.

WORK OF PAST YEAR.

The stone contractor, Mr. Jacob Friday, completed both his stone contracts on April 10, 1892, having deposited 54,686 tons of rock during the year.

The Government stone plant worked continuously till June 10, 1892, when lack of funds necessitated suspension of all active work. A small force was retained at the quarry to move railroad tracks and derricks, and to do such stripping and clearing up as would facilitate work under the next appropriation. The floating stone plant was laid up and a small force retained to give it a thorough overhauling to fit it for future work. During the year the plant put out 1,202 tons on the North Jetty and 52,439 tons on the South Jetty. The stonework by contract and hired labor aggregates 108,309 tons, the largest quantity yet handled here in any single year.

COST OF WORK.

Separate accounts were kept of the rolls and bills for the main office for the dredge, for the stonework by hired labor, and for the contract work including the cost of inspectors and their boats and crews. In these accounts each entry was made to show the liabilities (bills and pay rolls) incurred during each calendar month, no regard being paid to the date when payment was made. No attempt has been made to distribute the cost of the main office to the several branches of work. Such distribution must be purely arbitrary. These accounts are abstracted into the following table, showing work done, liabilities incurred, and cost per unit for each quarter of the year. The plant has been kept in good condition at all times; all repair bills have been

charged to work and not to plant. The only charges made to plant have been for such improvements as made the plant better than it was when new.

Liabilities incurred during fiscal year ending June 30, 1892, and how they were distributed.

[Total liabilities incurred during the year, $245,973.02.]

Class.	First quarter.	Second quarter.	Third quarter.	Fourth quarter.	Whole year.
Main office, bills and rolls	$1,151.35	$2,643.13	$2,919.88	$3,117.73	$8,378.59
Stone plant	$2,143.53	$1,473.88	$669.97	$24.50	$4,311.88
Dredge plant	$10,376.92	$644.63	$3,234.31	$11,415.20	$25,671.06
Deposited under contract ... tons	20,383	15,065	17,306	1,932	54,686
Cost of same	$42,407.28	$32,491.75	$35,989.23	$4,102.63	$114,990.89
Deposited by United States hired labor, tons	10,052	11,173	14,101	18,315	53,641
Cost of same	$19,813.48	$21,626.56	$25,277.43	$24,740.03	$91,420.60
Cost per ton by contract	$2.08	$2.16	$2.08	$2.12	$2.10
Cost per ton by United States hired labor	$1.97	$1.94	$1.79	$1.35	$1.70
Dredged ... cubic yards	42,336	40,184	18,649	...	101,169
Cost per cubic yard ... cents	9¾	12¼	13	...	11½
Cost laying up stone plant, June 10–30, 1892	...	...	...	$1,200.00	$1,200.00

June 30, 1892, value United States stone plant, $50,000; value United States dredge, $60,000.

It will be seen that the stonework done by contract and hired labor was nearly equal in amount, the excess by contract being only about 1,000 tons. The United States paid for stone put in by contract $23,500 more than for a nearly equal quantity put in by its own plant. The cost per ton by hired labor was 40 cents less than by contract. This is not a perfectly fair comparison, as the contractor had two contracts, one for work done in deep water, where the rock was rolled off by hand; the work was easy and the price was $1.90 per ton; the other for putting off rock on the higher parts of the jetties to raise them to high water. Here all rock had to be hoisted off the lighters by steam. The price for this work was $2.15 per ton. Adding the cost of inspectors, the first contract stone cost the United States $1.93 per ton; the second, $2.20 per ton. The United States plant did work identical with the high priced contract, so that the saving to the United States should really be 50 cents per ton, and not 40 cents as shown in the above table.

There was no dredging done by contract during the year to compare with the Government dredging, but the last contract price was 17¼ cents per yard, and the previous contract was let at 30 cents a yard. The United States dredging cost 11½ cents per yard. This is not as good a showing as was anticipated, as much time was lost and many repair bills were incurred on account of the boiler, which was too small for the work demanded of it. All these bills were charged as above stated to her work. By the 10th of February it became apparent that it was not safe to continue work longer without a new boiler, which has been built and put into the vessel. She will reach Charleston and will resume work about the middle of July.

METHOD OF COMBINING CONTRACT AND HIRED LABOR.

The most friendly relations have been maintained between the United States employés and the contractor's men. Mutual aid was constantly asked and given, and thus many delays and much expense was saved both parties. Authority was asked and obtained to rent United States plant

to the contractor, and this was frequently done, especially in the case of the tugboat. On many days the Government tug did towing for the contractor at cost ($15 a day), and, when needed, his tug did the same for the United States at the same price. No other tugs could be hired for this purpose for less than $100 a day, and many hundreds of dollars were thus saved, both to the United States and to Mr. Friday. Similar exchanges were made at the quarries near Edgefield, where Mr. Friday and the United States were working side by side in the same ledge of granite. When Mr. Friday had more stone on cars at Charleston than he could handle, the excess was purchased from him at cost and put out by the United States, if the Government had lighter room to accommodate it. The movement of the railroad cars was thus facilitated, the rate of progress accelerated, and the cost of quarrying reduced by keeping both quarries busy. The cost of rock has been much increased, both to the contractor and to the United States, by lack of car service. This is well shown in the great reduction of cost of United States work after Mr. Friday's contracts were completed, as this gave the United States enough cars to properly handle its rock. In the early part of the year the plant was not worked to anything like its full capacity, as it was uncertain how much of the funds would be required for contract work. After the contractor finished his contracts the Government plant averaged 8,000 tons a month, and this rate can be economically and advantageously maintained under future appropriations. The year's work has raised about three-fourths of a mile of the North Jetty to high water, about 1 mile of the South Jetty to the same height, and has reënforced and raised some of the lower parts of the South Jetty.

ANNUAL SURVEY.

The annual survey shows more marked changes in the Swash Channel in the last year than have been reported before in any like period. The area between the jetties on which there is less than 12 feet has greatly decreased, and a succession of deep areas nearly connecting show more than 15 feet depth at low water where such depths have not been shown on any previous survey. Their aggregate area is about 40 acres. This deep area extends some distance beyond the ends of the jetties. A narrow 12-foot channel appears all the way through. Swash Reef has practically disappeared from the Jetty Channel and now forms an extension of the South Jetty, and Jim Evans Shoal has been pushed down nearly to the outer end of the North Jetty. As defined by the 12-foot curve this shoal has been much reduced in area during the year. The survey this year was very extended, and is fully compared with previous surveys in the report of my assistant engineer, Mr. James P. Allen, who has rendered most valuable service in every way in carrying on the work most successfully.

The breakwater along the Mount Pleasant shore was begun and completed during the year by contract. The contractor was Mr. Hasell W. Crouch, of this city. He has taken great pains with his work, and the breakwater is an unusually straight and elegant piece of work of its class.

APPROPRIATIONS.

It is most unfortunate that at a time when work was going on more rapidly, more regularly, and at less cost than ever before in the history of this improvement the lack of funds has made it necessary to suspend operations and lose the best portion of this year for work. In the sum-

mer the days are long and the sea smooth, and every week of enforced idleness might otherwise have recorded a large amount of most important work accomplished. The improvement is just at the critical stage when rapid and continuous work is needed to assist the new channel to break completely through the bar, which now measures only a few hundred feet between 15 feet of water inside and out. Money spent now would save thrice its amount spent a year or two hence, when the material now in motion has had time to settle into some new position and become set and hard.

The utmost economy would be secured by any system of appropriations which would enable this important work to be prosecuted without continually recurring periods of idleness. Seven hundred and fifty thousand dollars could be advantageously spent in the next year.

With the balance of $16,685.64 on hand July 1, 1892, the Government stone plant will be cared for and the dredging will continue as long as the funds permit.

This work is in the collection district of Charleston, S. C., which is the port of entry. Amount of duties collected in calendar year 1891, $24,308.47.

Since the existing project of improvement has been adopted the following appropriations have been made:

By act of Congress approved—	
June 18, 1878	$200,000
March 3, 1879	200,000
June 14, 1880	170,000
March 3, 1881	175,000
By act of Congress passed August 2, 1882	300,000
By act of Congress approved—	
July 5, 1884	250,000
August 5, 1886	187,500
By act of Congress—	
Of August 11, 1888	350,000
Approved September 19, 1890	370,000
Total	2,202,500

Total expenditures to June 30, 1892, $2,185,814.36, which includes the cost of building shore protections on Sullivan Island and Mount Pleasant.

The following drawings and papers accompany this report:

Sheet 1. Map showing survey of 1892.
Sheet 2. Longitudinal profiles through Jetty Channel, constructed from mean soundings.
Sheet 3. Comparison of surveys of 1884 and 1892.
Report of Mr. James P. Allen, assistant engineer.
Table of commercial statistics furnished by the collector of the port.
Statistical letter received from Mr. Edward Willis.

Money statement.

July 1, 1891, balance unexpended	$308,052.39
June 30, 1892, amount expended during fiscal year	291,366.75
July 1, 1892, balance unexpended	16,685.64
July 1, 1892, outstanding liabilities	4,205.00
July 1, 1892, balance available	12,480.64
Amount appropriated by act approved July 13, 1892	225,000.00
Amount available for fiscal year ending June 30, 1893	237,480.64
Amount (estimated) required for completion of existing project	1,953,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	750,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building breakwater along Mount Pleasant Shore, South Carolina.

[Opened November 26, 1891.]

No.	Name of bidder.	Linear feet.	Price per whole.
1	Hasell W. Crouch	1,152	$4,300

Date of commencing work and monthly progress, as required by specification. Contract awarded to Hasell W. Crouch, as the price bid was reasonable.

REPORT OF MR. JAMES P. ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1892.

CAPTAIN: I have the honor to submit the following annual report for Charleston Harbor for the fiscal year ending June 30, 1892:

Work under Mr. Jacob Friday's two contracts was continued, these contracts having both been extended three months. The last work under the hand contract was done on April 8, and on the hoister contract on April 9, 1892. Four hundred and four tons of rock remaining on Mr. Friday's hands were purchased from him in position on the north jetty at contract price after the completion of his contracts. He deposited under the hand contract 6,449 tons of stone on the south jetty between 13,850 feet and 16,400 feet from the shore end.

Most of this was distributed so as to be about 25 feet wide at the crest and was brought up to low water. A small portion was brought up to high water with a narrow crest. Some of this part of the jetty had been brought up to low water last year and was so reported in the last annual report. It has been worked over again in order to fill low places. This stone was of large sizes.

Twelve thousand eight hundred and thirty-five tons of small rock have been placed on the central 40 feet of the south jetty from 4,120 to 6,032 feet from the shore end, and on the 60 feet south of this between 4,062 feet and 5,370 feet from the shore end. The object was to reinforce the south jetty just inside of the main ship channel. On the old jetty this additional covering was 1 foot thick, and on the 60 feet south it was 2 feet thick.

Under the hoister contract 32,966 tons have been placed on the north jetty from 9,150 to 12,730 feet from the shore end. The 404 tons already mentioned as having been purchased, extended this work to 12,760 feet from the shore end. This portion was brought up to high water. Mr. Friday also placed 2,032 tons on the south jetty, under the hoister contract, between 13,950 and 14,200 feet from the shore end. Most of it was brought up to high water.

Mr. Friday's plant consisted of one tugboat, three hoisters, and ten stone-lighters. Two of his hoisters had two engines each, and a carrying capacity of 400 tons. They were loaded and the rock was hoisted from their decks. This plan proved to be unsatisfactory, as a great deal of time was lost on account of their deep draft. They could not get up near enough at or near low water to place rock on the center line. No material additions were made to the United States plant during the year except that the hoister mentioned in the last annual report as under construction, was completed.

The United States quarry near Edgefield, S. C., has been operated continuously during the year. Thirty-two thousand eight hundred and ninety-four tons of rock have been taken out. It having been found that the quarry could not furnish rock as fast as it was needed to keep the United States plant in economical operation, 20,387 tons were purchased. Twelve hundred and two tons of rock were put off on the north jetty, between 6,713 and 6,745 feet from the shore end, and 52,439 tons on the south jetty, between 9,050 feet and 13,860 feet from the shore end. In both places the work was brought up to high water in pursuance of the same policy as heretofore, which is to bring the work up high with a narrow crest, so as to derive from it as soon as possible all the advantages to be gained by height. It is not expected that this height will be maintained for any great length of time.

The dredge *Charleston* arrived at Charleston, S. C., on July 4, 1891, and began work between the jetties on July 23, 1891. She continued working with occasional intermissions for repairs, mainly to the boiler, until February 10, 1892, and removed

101,169 cubic yards. At that time she was stopped because the boiler proved to be too small for the duty imposed upon it, and was dangerous to the safety of the vessel and to the lives of the crew. A new boiler was ordered from the Continental Iron Works, of Greenpoint, N. Y., and on April 21, 1892, the vessel went on to have it put in. It is expected that she will be back in Charleston and ready for work on or before August 1, 1892. During the time that she worked she proved herself to be a valuable and efficient machine.

No work was done under the dredging contract of Mr. B. C. Howell. Mr. Howell having been unable to overcome his financial difficulties his contract was annulled at the expiration of the time to which it had been extended.

Surveys.—The annual survey has covered a considerably larger area this year than for some years past. The soundings were taken between March 24 and June 10, 1892. The area north of the north jetty, Drunken Dick Shoal, and the area between the jetty channel and Morris Island, extending at least a half mile north and south of the south jetty, have all been sounded quite thoroughly. The area north of the north jetty was last sounded in 1883 and 1884, Drunken Dick Shoal and Beach Channel in 1887, and the remainder of the area in 1888. The survey of 1883–'84 covered the whole area embraced in this survey. Comparison will consequently be made with the maps of 1884, 1887, and 1888, except for the jetty channel, which as heretofore will be compared with the last year's map.

North of the north jetty the area of the shoal within the 9-foot curve has increased somewhat. The area within the 12-foot curve has also increased. In neither of these is the change so great as to indicate rapid filling in this place. The 15-foot and 18-foot curves show no marked change. The deep holes near the jetty, caused by ebb-tide overpour, have increased in depth and area where the jetty is low but have decreased where it has been raised, as would naturally be expected.

Drunken Dick Shoal and Beach Channel.—The area of Drunken Dick Shoal within the 9-foot curve, has slightly decreased since 1884, but the depths on this shoal are generally less, indicating no great change in the quantity of material. Beach Channel has been closed at its inner end, so that less than 3 feet at low water now shows where in 1884 there was a channel of between 13 and 14 feet. This channel has not materially changed in width west of the north jetty for half a mile, but has moved toward the south, apparently to accommodate the advance of the Sullivan Island Beach seaward. At the jetty it is narrower, as has been already reported, and east of the jetty it has changed but little. The most noteworthy change in this locality is the appearance of a pocket or incipient ebb tide channel across the jetty, about 3,000 feet from its shore end. There is now over 15 feet of water where breakers are shown in 1884. This has not broken through, for there is very shoal water east of its end, which is about 1,000 feet east of the jetty. The 12, 15, and 18 feet curves south of Drunken Dick Shoal show no marked changes except where this pocket occurs.

The trench formation appears on the west as well as on the east side of the north jetty, indicating strong flood as well as ebb currents, although the most decided trench is that due to the ebb-tide overpour.

A comparison with the map of 1887 shows that the changes heretofore noted were taking place at that time, although less advanced. I note, however, the following: That whereas the average depth of the shoalest part of Drunken Dick Shoal had remained about the same from 1884 to 1887 it now appears to have become shoaler, and the Beach Channel, as defined by the 15-foot curve, except near the Bowman Jetty, is wider now than in 1887, at which time it was reported to have decreased in width.

Main Ship Channel.—The Main Ship Channel and the area between it and Morris Island have been compared with 1888. The changes worthy of note are the following: The Main Ship Channel has widened south of the south jetty and for half a mile north of it The eastern limit of the channel has not changed, except near the jetty, but the increased width comes from the westward movement of the 15 and 18 foot curves. From a half mile north of the jetty to the north limit of the survey, these curves have moved eastward. North of the south jetty there is no marked change in the maximum depths, but to the south these have increased. The 9 and 12 foot curves along Morris Island Beach have not changed materially. There was in 1888 a point of the Fort Sumter Shoal extending to the south, about half a mile from Morris Island Beach. The end of this shoal, within the 12-foot curve, has withdrawn about a quarter of a mile towards the north, but there is another forming to the eastward, not far from the western limit of the channel. The limits of the survey preclude a complete study of this point. The same changes were in progress from 1884 to 1888, as indicated by the maps of these years. There is a trench formed along the north side of the south jetty near its shore end, about 1,200 feet long. This was shown in 1888, but it is now more extended and deeper. It is caused by the overpour during the flood tide, the flood currents along this shore being very strong.

Deep Pocket.—The deep pocket which is just south of the south jetty and about 8,500 feet from its shore end shows marked filling. This may be partially due to the fact that the dredge *Charleston* has dumped here most of the material which she removed. The security of the jetty at this point which until it was raised to low water was a source of considerable anxiety seems to be now tolerably well assured.

Swash Channel.—The mean soundings have been calculated and profiles platted from them as heretofore. Considerable scour is shown on the intermediate portion, slight filling inside and very marked filling on the outer end.

No. 2, which is nearest the channel indicated by the survey, has a slightly greater minimum depth in 1892 than in 1891. The inner 18-foot curve has slightly receded, while all of the outer curves, 12, 15, and 18 feet, have advanced seaward, notably more near the south jetty than near the north jetty. The 9-foot shoals between the jetties are small in area, there being one near the end of the north jetty and one along the south jetty, which is out of the way of vessels. A 9-foot shoal has formed almost exactly on the line of the south jetty, the outer end of which shows about 7 feet, where there was 16.6 feet last year. The area of less than 12 feet between the outer ends of the jetties has decreased. The movement and shapes of the curves indicate that the material which is carried out does not deposit directly in front, but works off somewhat to the south. The soundings show a 12-foot channel entirely through, but it is too narrow and crooked to be navigable as a 12-foot channel, and its permanence is doubtful. It is furthermore possible that more soundings might have shown lumps in it. A very marked increase of depth is indicated where the dredging was done and to the south of it. This is shown by large areas of over 15 feet in depth and some over 18 feet. As only about 100,000 cubic yards were removed this can not all be attributed to the dredging. Moreover, much of it is considerably south of the dredging range. It is probable that the movement of the dredge forward and back through the channel may have aided the removal of material by the currents. This idea is strengthened by the shape of the outer curves opposite the dredge cut. The greater part of the scour, however, is undoubtedly due to the action of the jetties. I find no noteworthy change in the areas north and south of the jetties. The general features in these localities have not changed materially. The curves just south of the end of the south jetty confirm the general statement already made that considerable material has moved around the end of this jetty.

Condition of the jetties.—The general profiles of both jetties is given on sheet No. 1; no survey has been made of the low portions. A few soundings and facts obtained in the progress of the general survey and an examination at low water show that these portions have practically the same heights that they had at the end of the last fiscal year, and no settlement is indicated.

Sullivan Island.—Both the high-water and low-water lines have advanced seaward, the former more than the latter. The maximum advance of the high-water line as compared with last year is about 100 feet. West of the Bowman Jetty the high-water line has advanced, but the low water has receded.

Morris Island.—The change in the high-water line is very slight except near the jetty both north and south, where it has advanced seaward. The low-water line has receded near the head of the island in some places 100 feet, with a maximum at the extreme north end of 200 feet. Near the jetty the low-water line has advanced seaward both to the north and to the south.

Mount Pleasant shore.—A breakwater 1,215 feet long was built at the western end of the village on the right of way granted to the United States by the town. It is constructed of piles treated with pine-oil creosote for their preservation, and driven 12 feet apart from center to center with an upper and lower horizontal piece, to which sheet spiles are spiked, these last as, in fact, all the timber, being treated with pine-oil creosote. A space was left in this breakwater where it crosses Hibben street, but this was afterwards partly filled with stone to preserve the ends of the pile work from wash. The work was done under contract with Mr. Hasell W. Crouch. There has been no notable washing of the beach as indicated by the receding of the high-water line, except at the western end of the village, where it has receded somewhat. The spur jetties at the eastern end of the town are in practically the same condition as they were at the end of the last fiscal year.

Inspectors, superintendents, and assistants.—The contract work has been inspected by Mr. J. E. Mikell, assisted by Mr. W. M. Smith. The hired labor work outside has been superintended by Mr. W. D. Gaillard. The overseer at the quarry was Mr. Geo. T. Sandford. The dredge was commanded by Capt. E. O. Patterson, with Col. F. L. Childs in charge of measurements. I have been assisted on surveys by Mr. L. L. Gaillard, and Mr. W. A. Leland. These gentlemen have filled their respective positions satisfactorily.

Very respectfully, your obedient servant,

JAMES P. ALLEN,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Charleston, S. C., from January 1, 1875, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	504	382, 018	11, 949	38	13, 144	326	198	88, 879	2, 404	740	484, 041	14, 379
1876	471	340, 439	10, 113	44	11, 898	335	224	101, 272	2, 768	739	453, 609	13, 216
1877	400	324, 919	9, 885	32	13, 972	308	336	105, 480	2, 851	668	444, 371	13, 044
1878	396	322, 527	9, 623	44	19, 935	455	329	163, 368	3, 967	772	505, 830	14, 045
1879	383	326, 681	10, 027	39	12, 505	319	249	121, 503	3, 292	668	460, 659	13, 638
1880	441	388, 026	20, 641	38	12, 412	327	191	110, 771	2, 595	670	511, 209	13, 563
1881	412	399, 732	10, 377	34	9, 430	272	257	121, 077	3, 073	703	530, 239	13, 722
1882	410	384, 690	9, 446	35	4, 807	224	200	105, 647	2, 648	645	495, 144	12, 318
1883	345	277, 538	7, 629	26	3, 002	157	239	113, 768	2, 958	610	394, 308	10, 744
1884	425	304, 382	9, 822	21	3, 910	145	214	134, 076	3, 269	690	442, 368	13, 236
1885	375	268, 477	9, 637	15	2, 344	97	187	106, 233	2, 586	577	377, 054	12, 320
1886	901	550, 209	....	20	3, 714	131	182	114, 507	2, 646	1, 103	668, 403	......
1887	927	656, 949	....	30	7, 074	199	127	67, 257	1, 607	1, 084	731, 280	......
1888	*924	601, 771	....	34	7, 750	252	127	72, 921	1, 779	1, 085	682, 442	......
1889	†330	481, 718	9, 708	30	6, 985	216	136	87, 101	1, 979	496	575, 804	[illegible]1, 903
1890	‡410	600, 776	13, 677	35	7, 205	242	120	81, 518	1, 828	565	689, 499	15, 745
1891	§417	680, 776	15, 695	27	4, 665	179	150	119, 199	2, 383	594	804, 640	18, 257

* Of these, 32 vessels (tonnage, 31,035), with crews numbering 608, were foreign.
† Of these, 29 vessels (tonnage, 9,440), with crews numbering 546, were foreign.
‡ Of these, 58 vessels (tonnage, 55,533), with crews numbering 1,110, were foreign.
§ Of these, 34 vessels (tonnage, 39,078), with crews numbering 717, were foreign.

CLEARED.

Year.	Coastwise No.	Coastwise Tons.	Coastwise Crew.	American vessels No.	American vessels Tons.	American vessels Crew.	Foreign vessels No.	Foreign vessels Tons.	Foreign vessels Crew.	Total No.	Total Tons.	Total Crew.
1875	461	328, 266	10, 830	57	24, 679	555	211	94, 595	2, 527	729	447, 540	13,912
1876	431	278, 744	9, 095	60	23, 598	546	230	103, 276	2, 812	721	405, 618	12, 453
1877	335	234, 429	7, 719	35	22, 767	423	250	108, 446	2, 910	620	365, 662	11, 052
1878	266	172, 988	5, 801	45	24, 397	479	398	149, 975	3, 591	509	347, 360	14, 045
1879	287	188, 212	6, 268	34	11, 282	292	278	149, 052	3, 643	599	348, 546	10, 203
1880	296	190, 733	6, 348	45	23, 210	481	246	155, 768	3, 375	587	369, 711	10, 204
1881	268	187, 569	5, 942	32	9, 239	255	278	153, 796	3, 464	578	350, 604	9, 661
1882	147	113, 699	3, 090	40	7, 375	273	263	158, 250	3, 584	450	379, 324	7, 546
1883	98	48, 714	2, 018	27	4, 560	181	299	154, 653	3, 815	424	207, 927	6, 014
1884	212	116, 020	4, 555	31	7, 845	217	276	161, 588	3, 727	519	285, 453	8, 499
1885	191	99, 658	5, 047	24	5, 217	164	204	119, 602	2, 836	419	224, 467	8, 047
1886	890	543, 259	....	25	5, 469	165	201	126, 943	2, 875	1, 116	675, 671	......
1887	888	610, 646	....	28	5, 837	189	173	115, 218	2, 546	1, 089	731, 701	......
1888	*911	580, 468	....	30	5, 848	211	144	96, 146	2, 105	1, 085	682, 462	......
1889	†46	358, 596	778	25	5. 080	174	165	112. 037	2, 495	236	155, 713	3, 467
1890	‡21	12, 863	292	41	10, 161	318	166	126, 078	2, 676	228	149, 102	3, 286
1891	§39	21, 197	436	32	6, 887	216	164	143, 398	2, 809	255	171, 482	3, 461

* Of these, 7 vessels (tonnage, 4,295), with crews numbering 62, were foreign.
† Of these, 4 vessels (tonnage, 2,960), with crews numbering 47, were foreign.
‡ Of these, 7 vessels (tonnage, 6,186), with crews numbering 135, were foreign.
§ Of these, 18 vessels (tonnage, 16,332), with crews numbering 303, were foreign.

COMMERCE.

Year.	Value of exports.	Value of imports.	Duties collected.
1875	$19, 655, 966	$680, 343	$80, 656. 00
1876	18, 088, 152	455, 562	89, 168. 00
1877	16, 917, 492	161, 237	46, 848. 00
1878	21, 167, 575	184, 127	36, 990. 00
1879	18, 693, 126	127, 981	24, 070. 00
1880	24, 939, 259	248, 158	46, 453. 98
1881	21, 927, 269	723, 049	99, 066. 23
1882	19, 907, 099	459, 970	45, 263. 33
1883	20, 144, 365	467, 648	48, 760. 69
1884	20, 833, 424	503, 504	36, 624. 76
1885	15, 157, 889	588, 191	32, 741. 68
1886	17, 410, 000	635, 000	24, 876. 00
1887	15, 288, 316	484, 063	30, 817. 00
1888	13, 006, 578	625, 770	76, 398. 00
1889	16, 080, 255	664, 696	16, 728. 82
1890	15, 204, 771	836, 626	18, 356. 81
1891	21, 906, 076	1, 204, 588	24, 308. 47

T. B. JOHNSTON,
Collector.

LETTER OF MR. E. WILLIS.

CHARLESTON, S. C., *May 31, 1892.*

CITY OF CHARLESTON TRADE REPORT, 1891.

The volume of the main articles making its business have all kept pace with 1890, and many even larger. The new buildings in the city and immediate vicinity have added very much to the city's capacity for business another year. The four new fertilizer works add new importance to this industry, and the new post-office, now being built with Winnsboro granite, will assist to increase our handsome public buildings that adorn our city.

The East Shore Terminal Railroad, skirting the water front, is one of the greatest factors in Charleston's developments for past twenty years, making us now equal to any southern port for water-front facilities or advantages.

Besides this the new city passenger railway, encircling the western boundary of the city, is going to supply a need long felt and much required.

Trade of Charleston, S. C., from January 1, 1890, to December 31, 1891.

EXPORTS.

	1890.			1891.		
	Number.	Tons.	Value.	Number.	Tons.	Value.
Upland cotton............bales..	521,628	123,876	$26,000,000	545,000	136,250	$25,000,000
Sea Island cotton.........bags..	13,303	2,300	1,330,000	13,415	2,219	1,075,000
Rice ....bushels..	800,000	12,500	1,250,000	*88,000	12,850	1,300,000
Rosin...................barrels..	220,000	30,000	400,000	170,000	44,000	285,000
Turpentine..............casks..	50,000	8,500	1,250,000	36,000	9,000	710,000
Phosphate rock:						
Crude	....	320,000	2,500,000	....	370,000	2,750,000
Ground	....	6,000	65,000	....	2,500	23,000
Fertilizers ....sacks..	2,750,000	275,000	5,000,000	....	288,000	4,800,000
Lumber, shingles, timber, railroad ties ....feet..	75,000,000	1,200,000	750,000	60,000,000	1,200,000	775,000
Cotton goods, domestic and yarns....................bales..	62,500	12,500	3,250,000	72,500	18,500	4,000,000
Cotton seed, seed meal cake......	....	3,000	50,000	....	1,500	30,000
Kaolin ....casks..	20,000	20,000	360,000	15,000	13,750	175,000
Vegetables and fruit.....crates..	70,000	4,000	180,000	165,000		
Strawberries ....quarts..	500,000	500	75,000	830,000	1,500	2,500,000
Potatoes.................barrels..	80,000	8,500	350,000	91,500		
Melons (State) ....carloads..	1,200	50,000	250,000	1,200	36,000	170,000
Miscellaneous	....	100,000	75,000	....	75,000	75,000
Total	....	2,077,676	43,135,000	....	2,211,069	43,668,000

* Barrels.

Trade of Charleston, S. C., from January 1, 1890, to December 31, 1891—Continued.

IMPORTS.

	1890.			1891.		
	No.	Tons.	Value.	No.	Tons.	Value.
Bacon ....pounds..	60,000,000	30,000	$3,600,000	63,000,000	30,150	$4,200,000
Flour........barrels..	180,000	18,000	1,000,000	182,000	17,500	950,000
Corn........bushels..	800,000	25,000	600,000	700,000	22,000	550,000
Hay........bales..	60,000	5,600	100,000	55,000	5,200	78,000
Oats........bushels..	160,000	2,500	70,000	155,000	2,400	70,000
Grist and meal........barrels..	100,000	10,000	280,000	120,000	12,000	250,000
Sugar........do....	100,000	15,000	1,500,000	100,000	15,000	1,400,000
Molasses........do....	5,000	1,000	100,000	8,000	1,200	160,000
Salt........sacks..	12,500	1,250	7,000	35,000	2,500	16,000
Cotton bagging, S. L........yards..	50,000	50	7,500	50,000	50	7,800
Bagging and burlaps........do...	4,000,000	2,000	250,000	6,200,000	10,000	675,000
Jute butts........rolls..	30,000	6,000	250,000	25,000	5,000	240,000
Petroleum and other oils ...barrels..	35,000	6,000	300,000	37,500	6,250	325,000
Ice........		30,000	70,000	....	35,000	125,000
Cigars........number..	17,500,000		....	15,000,000	....	....
Tobacco........pounds..	1,900,000	2,500	1,100,000	1,800,000	2,500	1,000,000
Paper, stationery, and bookbinding..	....	1,000	300,000	....	1,500	375,000
Groceries and dry goods........	....	100,000	25,000,000	....	125,000	25,000,000
Hardware........	....	70,000	2,000,000	....	70,000	2,100,000
Boots and shoes........	....	10,000	1,250,000	....	12,000	1,500,000
Crockery........	....	5,000	200,000	....	5,500	250,000
Drugs and medicines........	....	2,500	600,000	....	3,000	750,000
Granite, rubble........	450,000	72,500	160,000	....	93,469	270,175
Marble, brownstone, blocks........		575			1,610	
Curbing, paving........		1,400			4,912	
Kainit........	....	14,000	90,000	....	40,000	195,018
Brimstone........	....	20,000	325,000	....	24,316	580,400
Nitrate of soda........	....	3,200	100,000	....	3,035	75,000
Muriate of potash........	....	2,800	90,000	....	2,506	88,915
Lime, cement, plaster........	....	10,000	25,000	....	12,500	30,000
Manufactures........	....	25,000	7,500,000	....	27,500	10,000,000
Fertilizers........	....	....	....	....	1,577	12,000
Pyrites........	....	....	....	....	17,671	62,050
Total........	....	492,875	46,874,500	....	612,246	51,335,358

Tonnage from Charleston, 1890 and 1891.

From August 31 to September 1.	Foreign.	Domestic.	Total tons.
1890:			
Steamships........	80	257	....
Ships........	1	....	....
Barks........	81	6	....
Brigs........	11	10	....
Schooners........	4	447	....
	177	715	790,325
1891:			
Steamships........	93	306	....
Barks........	73	9	....
Brigs........	12	18	....
Schooners........	3	453	....
Total........	181	786	938,250

M 11.

IMPROVEMENT OF ASHLEY RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see Appendix S 8, Annual Report for 1873.

ORIGINAL CONDITION.

The river was obstructed by two shoals, with not over 9 feet of water on them.

PLAN OF IMPROVEMENT.

A depth of from 10 to 11 feet was to be secured by dredging.

WORK PRIOR TO JUNE 30, 1891.

Twenty-two thousand one hundred and twenty-four cubic yards of material had been removed, and the desired depth had been obtained and maintained.

WORK OF PAST YEAR.

No work was done. With the approval of the Department the balance ($826.34) on hand is held for the present to be expended when necessary in dredging at any point on the river which may shoal to a less depth at low water than 10 or 11 feet.

REMARKS.

No new transportation lines have been established on this river during the year. The improved reaches are in satisfactory condition. The new bridge near Charleston has been changed by its owners so that its draw-span is now correctly located and fendered. Appended to this report is a statement prepared by Mr. E. Willis, of Charleston, giving the required freight statistics. During the year the freight passing over this stream has aggregated 415,800 tons.

This river is tributary to the collection district of Charleston, S. C. Charleston is its port of entry. Amount of duties collected in the calendar year of 1891, $24,308.47.

For this improvement the following appropriations have been made:

By act of Congress approved—	
June 14, 1880	$1,000
March 3, 1881	1,500
July 5, 1884	2,000
August 5, 1886	1,000
Total	5,500

Total expenditures to June 30, 1892, $4,673.66.

Money statement.

July 1, 1891, balance unexpended	$826.34
July 1, 1892, balance unexpended	826.34

LETTER OF MR. E. WILLIS.

CHARLESTON, S. C., *May 31, 1892.*

Ashley River, South Carolina.—This main artery of the phosphate and fertilizer trade has added to its banks yearly new fertilizer works, increasing the traffic on the river of the very large amount of bulky materials used in making commercial manures, and supplying an outlet for the many phosphate mining companies higher up the river. Steamers and sail vessels now traverse the stream with much more ease, the risk of grounding being very small compared to its condition a few years back. It is the source of a growing and important industry that plays no unimportant part in Charleston's export and import trade which seems to grow now every year.

Commercial statistics, Ashley River, South Carolina.

	Phosphate rock.		Sulphur, kainit, blood, potash, cotton-seed meal, pyrites, tankage, etc.		Timber, lumber, shingles, cross-ties, hoop poles, etc.		Miscellaneous.		Total value
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	
1888...	....	$1,045,000	....	$750,000	....	$30,000	....	$25,000	$1,850,000
1889...	....	1,200,000	....	800,000	....	35,000	....	30,000	2,065,000
1890...	250,000	1,600,000	50,227	900,000	10,000	40,000	5,000	40,000	2,580,000
1891...	300,000	2,100,000	98,800	1,016,000	12,500	50,000	4,500	30,000	3,196,000

Total tonnage, 415,800.

M 12.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For original project see page 1073, Annual Report for 1881. For modified project see page 1196, Annual Report for 1889.

ORIGINAL CONDITION.

Wappoo Cut was a narrow, crooked tidal stream, with but little depth, connecting Ashley and Stono rivers.

PLAN OF IMPROVEMENT.

The project provides for securing a sufficiently straight and continuous channel 60 feet wide between low water lines and 6 feet deep at low water from Ashley to Stono rivers. The bulk of the work is dredging. To maintain the channel two training walls at Stono entrance and three closing dams are to be made and some bank protection done. The estimated cost is $88,000.

WORK PRIOR TO JUNE 30, 1891.

One hundred and seventy thousand seven hundred and nine cubic yards of dredging had been done. A number of snags, stumps, and overhanging trees had been removed, and a bulkhead had been built across the mouth of Pompey Cut. The south side of Elliott Cut had been revetted with stone for a length of 1,300 feet.

WORK OF PAST YEAR.

No work has been done, as the balance could be used to better advantage in connection with the next appropriation for the work.

REMARKS.

One new transportation line has been established through this cut during the year. During the year the freight passing over this stream has aggregated 140,000 tons.

With the balance of $2,583.23 on hand July 1, 1892, a dam will be built across the old slough to the south of the new cut, and the banks of Elliott Cut will be revetted as far as the funds will allow in accordance with the revised project.

This work is in the collection district of Charleston, S. C., which is the port of entry. Amount of duties collected in the calendar year of 1891, $24,308.47.

The following appropriations have been made for this improvement:

By act of Congress—	
Approved March 3, 1881	$10,000
Passed August 2, 1882	10,000
Approved July 5, 1884	3,000
Approved August 5, 1886	5,000
Of August 11, 1888	5,000
Approved September 19, 1890	10,000
Total	43,000

Total expenditures to June 30, 1892, $40,416.77.

Money statement.

July 1, 1891, balance unexpended	$2,586.23
June 30, 1892, amount expended during fiscal year	3.00
July 1, 1892, balance unexpended	2,583.23
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	12,583.23
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

LETTER OF MR. E. WILLIS.

CHARLESTON, S. C., *May 31, 1892.*

Wappoo Cut, South Carolina.—This narrow, crooked, sluggish tide stream, the waterway from Charleston to Stono River, forming inland passage to Savannah, Beaufort, and Florida, by the wisdom of the U. S. Government, by straightening the cut, by dredging, and connecting it with Elliott Cut, has transformed it into a pleasant, short, and now reliable route, removing all the annoyance to navigation formerly experienced, and allaying all risk to sail vessels and steamers and flats, now being water enough for regular communication at all times with the city.

Commercial statistics, Wappoo Cut, South Carolina.

Articles.	1888.		1889.		1891.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Phosphate rock .... tons	60,000	$300,000	70,000	$475,000	75,000	$525,000
Sea island cotton ..... bags	6,000	360,000	10,000	750,000	12,000	800,000
Rice ..... bush	150,000	150,000	250,000	262,500	240,000	250,000
Vegetables ..... crates	120,000	240,000	80,000	125,000	90,000	160,000
Fertilizers ..... tons	2,000	30,000	2,500	40,000	1,400	21,000
Lumber ..... feet	20,000,000	160,000	22,500,000	190,000	25,000,000	200,000
Shingles, ties, and other articles				25,000		20,000
Total		1,240,000		1,867,500		1,976,000

Total tons transported through the cut—	
1890	134,000
1891	140,000

M 13.

IMPROVEMENT OF EDISTO RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examinations, see page 1140, Annual Report for 1881. For modified project, see page 1168, Annual Report for 1889.

ORIGINAL CONDITION.

The river was choked with snags and had many half-formed natural cut-offs.

PLAN OF IMPROVEMENT.

The project provides for snagging, etc., to give easy navigation for rafts and flat boats from Guignards Landing to the mouth of the river, a distance of about 260 miles, at an estimated cost of $33,385.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points 227 miles and no miles above the mouth, 26,497 logs, snags, and overhanging trees, etc., having been removed from the channel and banks. Numerous outlets into the swamps had been closed, and one large natural cut-off had been opened and made the main channel of the river.

The North Fork was roughly cleared for raft navigation for width of 60 feet and depth of 18 inches at low water between Orangeburg Bridge and 8 miles below.

WORK OF PAST YEAR.

The river and harbor act of September 19, 1890, in providing for this improvement, contains a requirement that the money appropriated should be spent in equal portions in the North and South Forks. In accordance therewith work was commenced near Orangeburg, on the North Fork, and at New Bridge, on the South Fork, and no work was done on the main river below the "forks." The original project did not provide for any work on the North Fork of the Edisto River, and, therefore, the $2,500 provided for such work should not be charged against the original estimated cost of this improvement.

The average cost of removing obstructions was about 38 cents for the North and 54 cents for the South Fork.

For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. James P. Allen, who has shown his usual zeal and ability.

REMARKS.

No new transportation lines have been established on this river during the year. With the balance of $172.26 on hand July 1, 1892, nothing can be done.

During the year the freight passing over this stream has aggregated 132,580 tons.

This river is tributary to the collection district of Charleston, S. C. Charleston on the north and Beaufort on the south are the nearest ports of entry. Duties on imports collected in the calendar year 1891 at the custom-house at Charleston, $24,308.47; at Beaufort, S. C., $31.50.

For this improvement the following appropriations have been made:

By act of Congress—	
Passed August 2, 1882	$8,000
Approved July 5, 1884	5,000
Approved August 5, 1886	3,000
Of August 11, 1888	5,000
Approved September 19, 1890	5,000
Total	26,000

Total expenditures, including June 30, 1892, $25,827.74.

For table of commercial statistics furnished by the collector of Charleston, S. C., see this year's annual report for Charleston Harbor. For table of commercial statistics furnished by the collector of Beaufort, S. C., see this year's annual report for Salkahatchie River.

Money statement.

July 1, 1891, balance unexpended	$4,193.25
June 30, 1892, amount expended during fiscal year	4,020.99
July 1, 1892, balance unexpended	172.26
Amount appropriated by act approved July 13, 1892	7,385.00
Amount available for fiscal year ending June 30, 1893	7,557.26

REPORT OF MR. JAMES P. ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1892.

CAPTAIN: I have the honor to submit the following report for Edisto River, South Carolina.

The following work was done on the North Fork: Seventeen hundred and thirty-three trees and 378¼ cords of brush were cut from the banks, and 1,381 logs, 423 stumps, 537 large snags, and 47½ cords of small snags were removed from the channel, covering 26 miles in length of river between Orangeburg and the junction of the North and South Forks. The channel is 60 feet wide and 18 inches deep at low water. Of the total amount expended six-tenths were used on the banks and four-tenths in the channel. The average cost of obstructions removed was 38 cents.

On the South Fork, 440 trees and 122 cords of brush were cut from the banks, and 361 logs, 400 stumps, 1,005 large snags, and 76 cords of small snags were removed from the channel, which is 60 feet wide and 18 inches deep at low water. Of the total amount expended one-fourth was used on the banks and three-fourths were used in the channel. The average cost of obstructions removed, 54 cents. This work was done between New Bridge and the junction of the North and South Forks.

Inclosed is a statement of the business of the whole river, which has been prepared by Mr. J. D. Ackerman. Mr. Ackerman has superintended the work on the North Fork, and Mr. B. G. Willis that on the South Fork. They have both been active and efficient in the discharge of their duties.

Very respectfully, your obedient servant,

JAMES P. ALLEN,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

COTTAGEVILLE, S. C., *June 4, 1892.*

I beg herewith to send you a report of the commerce passing over the Edisto River, 1891:

Articles.	1887.		1888.		1889.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Sawed lumber...feet B. M..	30,000,000	$240,000.00	32,000,000	$256,000.00	32,500,000	$260,000.00
Hewn timber..........feet..	15,000,000	90,000.00	15,000,000	90,000.00	18,000,000	126,000.00
Round timber ..linear feet..	1,500,000	75,000.00	2,000,000	100,000.00	1,500,000	75,000.00
Cross-ties.............feet..	38,000	3,500.00	60,000	4,800.00	2,000,000	160,000.00
Rice..............bushels..	124,982	149,970.40	130,114	156,136.68	128,340	154,008.00
Naval stores.......barrels..	....	....	....	....	....	....
Wood..........	....	....	....	....	....	....
Phosphate.........tons......	....	....	....	....	....	....
Miscellaneous, cord-wood, etc..........	....	10,000.00	....	$8,000	....	6,000.00
Total..........	....	568,478.40	....	614,936.68	....	781,008.00

Articles.	1890.		1891.	
	Quantity.	Value.	Quantity.	Value.
Sawed lumber..........feet B. M..	35,000,000	$280,000.00	37,000,000	$296,000.00
Hewn timber..........feet..	17,000,000	102,000.00	12,000,000	72,000.00
Round timber..........linear feet..	1,500,000	75,000.00	1,500,000	75,000.00
Cross-ties..........feet..	2,500,000	200,000.00	2,000,000	160,000.00
Rice..........bushels..	128,796	154,555.20	130,760	156,912.00
Naval stores..........barrels..	900	3,600.00	6,200	4,800.00
Wood..........	....	....	....	7,000.00
Phosphate..........tons..	....	....	25,000	125,000.00
Miscellaneous, cord-wood, etc..........	....	8,000.00	....	....
Total..........	....	823,155.20	....	896,712.00

132,580 tons, including 105,500 tons timber.
Respectfully submitted.
Your obedient servant,

J. D. ACKERMAN.

Capt. F. V. ABBOT.

M 14.

IMPROVEMENT OF SALKAHATCHIE RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination, see page 1144, Annual Report for 1881.

ORIGINAL CONDITION.

The river was choked with logs and snags, and in some places was divided into small branches by numerous low-lying islands.

PLAN OF IMPROVEMENT.

The project provides for clearing the channel for rafts and flat-boats from a point 5 miles above Tobys Bluff to Hickory Hill, 46 miles above the river mouth, a total length of 77 miles, at an estimated cost of $18,000.

WORK PRIOR TO JUNE 30, 1891.

The river had been snagged between points 46 miles and 123 miles above the mouth, 12,800 logs, snags, overhanging trees, etc., having been removed from the channel and banks. Over 181 outlets into the swamp were closed; a dam was built to remove a local shoal; one natural cutoff was widened and made the main channel of the river, and one bad cutoff was closed.

WORK OF PAST YEAR.

No work was done, as the river was in a sufficiently navigable condition for the business passing over it.

REMARKS.

No new transportation lines have been established on the river during the year. With the balance of $4,517.07 on hand July 1, 1892, the river will be maintained in fair rafting order.

As the appropriation of September 19, 1890, completes the estimated cost for this improvement a considerable balance will be held in hand to maintain the river in a navigable condition in the future. During the year the freights passing over this stream have aggregated 13,300 tons.

This river is tributary to the collection district of Charleston, S. C. Beaufort is the nearest port of entry. Duties on imports collected at the custom-house at Beaufort, S. C., in 1891, $31.50.

For this improvement the following appropriations have been made:

By act of Congress passed August 2, 1882	$5,000
Approved July 5, 1884	3,000
Approved August 5, 1886	2,000
Of August 11, 1888	3,000
Approved September 19, 1890	5,000
Total	18,000

Total expenditures, including June 30, 1892, $13,482.93.

Money statement.

July 1, 1891, balance unexpended	$4,524.80
June 30, 1892, amount expended during fiscal year	7.73
July 1, 1892, balance unexpended	4,517.07

COMMERCIAL STATISTICS.

Arrival and clearances of vessels and commerce at Beaufort, S. C., from January 1, 1888, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports. American vessels.			Foreign ports. Foreign vessels.			Total.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1888	103	121,207	2,630	3	1,093	26	30	21,785	422	136	144,085	3,078
1889	98	128,834	2,728	2	1,461	19	58	54,464	1,096	158	230,193	3,853
1890	43	49,173	927	7	2,987	75	52	48,656	972	102	100,816	1,974
1891	37	40,145	786	3	1,567	26	22	21,503	416	62	63,215	1,222

CLEARED.

Year.	Coastwise.			Foreign ports. American vessels.			Foreign ports. Foreign vessels.			Total.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1888	57	63,287	1,566	3	1,465	33	78	85,523	1,561	138	150,275	3,160
1889	57	73,744	1,872	...	...	...	98	99,898	1,944	155	173,642	3,816
1890	12	6,436	127	1	101	14	88	94,285	1,828	101	100,822	1,969
1891	7	3,921	75	...	...	...	51	56,300	932	58	60,221	1,007

Arrival and clearances of vessels and commerce at Beaufort, S. C., etc.—Continued.

COMMERCE.

Year.	Value of exports.	Value of imports.	Duties collected.
1888	$850,393.00	$65,645.86	$17.00
1889	1,083,085.00	24,266.00	160.00
1890	1,640,197.00	41,005.00	....
1891	627,851.00	137,942.54	31.50

ROBERT SMALLS,
Collector.

LETTER OF MR. W. D. NILES.

SALKAHATCHIE RIVER, SOUTH CAROLINA, *June 10, 1892.*

DEAR SIR: You will find below a tabulated statement of commercial statistics of Salkahatchie River, South Carolina, for the year 1891; the data for this statement I obtained from the written statements of the men doing the business on the river. I herewith inclose said statements.

Articles.	1887.		1888.		1889.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Lumber, sawed........feet, B. M..	4,450,000	$32,050	3,000,000	$30,000	3,500,000	$31,500
Timber....................do....	....	....	400,000	2,000	160,000	800
Cross-ties...............number..	41,000	13,120	40,000	12,000	17,000	4,590
Rice ....bushels..	200,000	250,000	170,000	200,000	175,000	218,750
Naval stores ....casks..	2,125	38,875	2,000	36,000	2,000	34,000
Rosin....................barrels..	9,798	15,000	8,000	16,000	8,000	12,000
Miscellaneous	....	....	....	4,000	....	10,000
Total	....	342,045	....	300,000	....	311,640

Articles.	1890.		1891.	
	Quantity.	Value.	Quantity.	Value.
Lumber, sawed............feet, B. M..	3,000,000	$27,000	100,000	$900
Timber............................do....	....	....	3,500,000	31,500
Cross-ties ....number..	....	....	15,000	4,500
Rice............................bushels..	200,000	250,000	175,000	200,000
Naval stores......................casks..	450	8,100	115	2,300
Rosin ....barrels..	4,500	6,750	1,125	1,400
Miscellaneous..............................	....	5,000	....	....
Total......................................	....	296,850	....	240,600

NOTE.—Figures for 1887 to 1890, inclusive, were added in U. S. Engineer Office, Charleston, S. C., from previous reports.

TOTAL TONS.

1889	16,000
1890	13,000
1891	13,300

Rice is shipped only over that part of the river called Combahee. Total tonnage of the above is about 13,300.

Respectfully, yours,

W. D. NILES.

Capt. F. V. ABBOT,
Corps of Engineers, U. S. A.

M 15.

IMPROVEMENT OF BEAUFORT RIVER, SOUTH CAROLINA.

REFERENCE TO PAST REPORTS.

For preliminary examination see page 1235, Annual Report for 1890.

ORIGINAL CONDITION.

There was a thoroughly good 7-foot channel between the town of Beaufort and Coosaw River, except at a point called Brickyard, near Coosaw mouth. The least depth here was about 4 feet at low water, and the channel when deep enough was too narrow.

PLAN OF IMPROVEMENT.

It is proposed to deepen and widen the channel by dredging sufficiently to give a continuously wide 7-foot channel at low water all the way through. The estimated cost is $25,000.

WORK PRIOR TO JUNE 30, 1891.

Three thousand seven hundred and fifty four cubic yards have been dredged from the mouth of the Brickyard Creek.

WORK OF PAST YEAR.

Dredging under contract with Mr. Thomas Young, of Charleston, S. C., continued till May 26, 1892, at which time the contract was completed. Twenty-eight thousand five hundred and twelve cubic yards were dredged during the year. A 7-foot channel all the way through has been secured. For details of work done and commercial statistics reference is made to the report of my assistant engineer, Mr. James P. Allen, who has shown his usual zeal and ability.

REMARKS.

No new transportation lines have been established on this river during the year.

The balance of $2,915.05 on hand July 1, 1892, will be retained until further funds are provided by Congress.

During the year the freight passed over this stream has aggregated about 202,235 tons.

This river is in the collection district of Beaufort, S. C. Beaufort is its port of entry. Amount of duties collected in the calendar year of 1891, $31.50.

For this improvement the following appropriations have been made:

By act of Congress approved September 19, 1890, $12,500.

Total expenditures including June 30, 1892, $9,584.95.

For table of commercial statistics, furnished by the collector of Beaufort, S. C., see this year's annual report for Salkahatchie River, South Carolina.

Money statement.

July 1, 1891, balance unexpended	$11,896.83
June 30, 1892, amount expended during fiscal year	8,981.78
July 1, 1892, balance unexpended	2,915.05
Amount appropriated by act approved July 13, 1892	12,500.00
Amount available for fiscal year ending June 30, 1893	15,415.05

REPORT OF MR. JAMES P. ALLEN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., June 30, 1892.

CAPTAIN: I have the honor to submit the following report for Beaufort River, South Carolina.

Work under the contract of Mr. Thomas Young, of Charleston, S. C., was continued during the year until May 26, on which date the last dredging under this contract was done. Mr. Young's contract was extended twice upon his request, first from December 31, 1891, to March 31, 1892, and later from March 31, 1892, to June 30, 1892.

The dredging was done on three ranges, the first over a shoal just within the mouth of Brickyard Creek, the second beginning about 1,400 feet from where the first ended, and extended to the next bend, and the third continuing the channel from this bend through a portion of the next reach. These have been designated Ranges 1, 2, and 3 respectively. The greater part of the dredging on Range No. 1 was through mud, but at the inner end of this range a sand shoal was encountered where the work was more difficult. A cut was made at this point 1,000 feet long, 150 feet wide, and 7 feet deep at low water, and 14,591 cubic yards of material were removed.

On Range No. 2 a channel 1,100 feet long, 175 feet wide, and 7 feet deep at low water was secured, the material removed being mud, and amounting to 3,473 cubic yards.

On Range No. 3 the cutting was about 900 feet long to obtain a channel 200 feet wide and 7 feet deep at low water, mainly through mud. Ten thousand four hundred and forty-eight cubic yards of material were removed.

When the contract was made it was supposed that rock would be encountered in some places at a less depth than 7 feet at low water, but this did not prove to be so and no payment was made for the removal of rock. The dredgings were dumped at first in Coosaw River, about a quarter of a mile outside of the mouth of the creek, but complaint was made that they were being dumped too near the channel entering Brickyard Creek from Coosaw River, and examination proved this to be the case. The Brickyard Creek Channel at this point was both shallow and narrow, and there was not sufficient room to dump between it and the marsh on the south side; consequently the dredgings were removed to the further side of Coosaw River, making it necessary to pay the greater towage for a large portion of the balance of the work. Later still the material was dumped in McCalley Creek, which proved to be a very good dumping ground, except that the towboat could not get into it at all stages of the tide. Five thousand one hundred and fifty-five cubic yards of material were dumped a quarter of a mile outside of the mouth of Brickyard Creek, less than one mile tow; 11,258 cubic yards were dumped on the north side of Coosaw River, more than 1 and less than 2 miles; 1,916 cubic yards were dumped in McCalley Creek, less than 1 mile from dredge, and 10,183 cubic yards were dumped in McCalley Creek more than 1 and less than 2 miles from dredge.

The contract work was very judiciously and faithfully inspected by Mr. W. D. Niles. After the completion of the dredging a careful hydrographic survey of a portion of the creek was made by Mr. W. A. Leland, assisted by Mr. W. M. Smith and Mr. J. H. Du Pré. Mr. Leland deserves credit for the prompt and thorough manner in which the survey was made. A copy of his map is herewith submitted. A 7-foot channel is shown entirely through, except at the junction of ranges 1 and 3. Here the channel is slightly less than 7 feet. The 7-foot channel is too narrow in several places, more especially beyond the point where this year's dredging ended, and should be widened under another appropriation. The cut on Range No. 1 should be widened considerably and a shoal which is shown in the channel from Coosaw River into Brickyard Creek should be cut through. Rock will probably be encountered in making this last-mentioned cut. This rock is the phosphate rock which abounds in the locality and should be removed at comparatively small expense, as its market value will offset the cost of removal to a contractor.

Very respectfully, your obedient servant,

JAMES P. ALLEN,
Assistant Engineer.

Capt. FREDERIC V. ABBOT,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

BEAUFORT, S. C., *June 10, 1892.*

SIR: You will find below a tabulated statement of the commerce passing over that part of Beaufort River, South Carolina, known as Brickyard Creek, for year 1891. The data for this statement I obtained from the written statement of the business men doing business through said Brickyard Creek.

Articles.	1891. Quantity.	1891. Value.
Lumber, timber, railroad ties .... feet	4,120,000	$37,500
Shingles .... number	100,000	500
Wood .... cords	600	1,800
Coal .... tons	7,300	29,000
Phosphate, rock .... do	173,000	820,000
General merchandise, machinery, hardware, etc .... do	9,150	300,000
Lint cotton, seed cotton .... do	1,600	140,000
Rough rice .... do	1,000	50,000
Total	....	1,378,800

Aggregate tons of freight transported through Brickyard Creek during the year was 202,235 tons.

Aggregate tonnage, value, and number of trips of vessels passing through that part of Beaufort River, South Carolina, known as Brickyard Creek during the year 1891.

No.	Class.	Aggregate ton.	Aggregate value.	Aggregate number trips.
3	Passenger boats	900	$40,000	140
16	Tugboats	1,000	170,000	1,500
37	Dredges, wash boats, lighters	6,000	280,000	5,500
20	Coastwise vessels	10,000	500,000	20
	Steam pleasure yacht	250	203,000	15
30	Small boats from 2 to 50 tons	400	12,000	500
3	Pilot boats	100	10,000	75
2	Revenue cutter			
1	Buoy tender	1,100	160,000	30
1	Fish Commission boat			
	Total	19,750	1,375,000	7,780

Five thousand passengers passed over the creek during the year.

W. D. NILES.

Capt. F. V. ABBOT,
Corps of Engineers, U. S. A.

M 16.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On May 2, 1892, two wrecks in Quinby Creek, the eastern branch of the Eastern Branch of the Cooper River, were reported to me as being dangerous to navigation, and also a third wreck in the Eastern Branch of Cooper River not far below the mouth of Quinby Creek. The matter was reported to the Chief of Engineers and an allotment of $100 was asked and obtained to make an examination looking to their removal. This examination was made on June 17, 1892. All three wrecks were found to be obstructions to navigation and of a dangerous character. It is estimated that they can be removed for the following amounts, viz:

The lower wreck is that of a tugboat, the *B. F. Huger*, past which all the commerce, reported in the appended letter of Capt. John Ball, is carried. It can be removed for $150.

The second and third wrecks are the remains, respectively, of a schooner and sloop, and past them the commerce to and from Quinby Bridge Landing and Quinby Landing is carried. The schooner can be removed for $400 and the sloop for $200. All three wrecks come plainly under the provision of the law.

STATISTICAL LETTER OF CAPTAIN JOHN BALL.

COOPER RIVER AND QUINBY CREEK, SOUTH CAROLINA,
Charleston, S. C., July 1, 1892.

DEAR SIR: At your request I endeavor to give you as near as possible the amount of freight that passes the wrecks reported sometime ago in Quinby Creek, viz: From the bridge landing, Quinby Creek, about 12,000 to 13,000 cross-ties, valued at $295 a thousand. Wood, oak, and pine, about 2,500 cords, average value, $3 a cord. Naval stores, 2,500 barrels rosin, $2.75 to $3.50 per barrel. Three hundred casks spirits turpentine, value $15 a cask. Merchandise up to bridge, $10,000 to $12,000. From Huger's bridge and Inabinet's landings, about 3,500,000 feet of lumber (by boat), 2,500 barrels rosin, 300 casks spirits turpentine, 500 cords wood, and merchandise up river, $8,000 to $10,000. From Quinby landing, wood, 2,500 to 3,000 cords, average value, $3 a cord. Cross ties, 13,000, at $295 per thousand; merchandise up river, about $500. The above is the best I can find out, and hope will be satisfactory.

Respectfully, yours,

JOHN BALL.

Capt. F. V. ABBOT.

APPENDIX N.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, AND OF CUMBERLAND SOUND, GEORGIA.

REPORT OF CAPTAIN O. M. CARTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Savannah Harbor, Georgia.
2. Savannah River, Georgia.
3. Darien Harbor, Georgia.
4. Altamaha River, Georgia.
5. Oconee River, Georgia.
6. Ocmulgee River, Georgia.
7. Brunswick Harbor, Georgia.
8. Jekyl Creek, Georgia.
9. Cumberland Sound, Georgia.
10. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEYS.

11. Inside route between Doboy and Sapelo, Georgia.
12. Inside route between Savannah, Georgia, and Fernandina, Florida.
13. Brunswick Outer Bar, Georgia.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 1, 1892.

GENERAL: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1892, upon the works of river and harbor improvements then in my charge.

Very respectfully, your obedient servant,

O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

N 1.

IMPROVEMENT OF SAVANNAH HARBOR, GEORGIA.

Operations for improving this harbor have been carried on during the last fiscal year in accordance with a project of improvement approved by the Secretary of War July 22, 1890, and printed as part of

Appendix O 1, Annual Report of the Chief of Engineers for 1890. For a special history of past work, see pages 1012–1023, Annual Report of the Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

In 1873, before the work of improvement was inaugurated, the usual draft of vessels navigating the river at high water was 14.5 feet. The mean rise and fall of the tide was about 6.5 feet at the city of Savannah, and 7 feet at the mouth of the river.

PLAN OF IMPROVEMENT.

The plan of improvement under which operations have been carried on during the last fiscal year provides for the establishment of a channel depth of 26 feet at mean high water from the city of Savannah to the sea. The mean rise and fall of tides varies from 6.97 feet at Fort Pulaski to 6.07 feet at the barge office in the city of Savannah. The principal features of the project of improvement, which is printed as a part of Appendix O 1, Annual Report of the Chief of Engineers for 1890, are:

(1) The enlargement of Drakie Cut.

(2) The entire or partial removal of King Island.

(3) The construction of a deflecting jetty from Argyle Island.

(4) The partial removal of Marsh Island and the closing of the channel north of it.

(5) The construction of a training wall from Marsh Island to Kinsey Point and the enlargement of the river near there.

(6) The construction of a training wall at Garden Bank.

(7) Spur jetties or bank protection in the Wrecks Channel, and a deflecting jetty at Mackay Point.

(8) The removal of a portion of Dam No. 15.

(9) The closing of Duck Puddle.

(10) The construction of shore protection and of training walls between the wing dams in North Channel from the Upper Flats to the Oyster Bed.

(11) The construction of training walls extending eastward from Cockspur Island and the Oyster Bed.

(12) Dredging is provided for between the Cross Tides and Tybee Roads.

The estimated cost of this improvement is $3,500,000, providing funds are regularly and adequately supplied.

Prior to 1826 an expenditure of about $100,000, raised by a tax upon shipping entering the harbor, was made under the direction of the commissioners of pilotage in clearing the river of wrecks, and in otherwise improving its condition, and between 1867 and 1871 an expenditure of $157,000 was made by the city of Savannah in dredging on the shoals between Cross Tides and the sea. From 1826, the date of the first appropriation made by the United States for the river, up to the date of beginning operations according to the 26-foot plan of improvement, appropriations aggregating $1,879,096.64 were made by Congress for the work.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

In 1872 the United States Engineer Department resumed charge of the improvement of the harbor, and from that time up to July 1, 1874

(since which date operations have been carried on in accordance with the 22-foot plan of improvement described on page 1246, Annual Report of the Chief of Engineers for 1890), there were removed from the channel 6 vessels, 16 cribs, and 1 sunken lighter, besides 166,498 cubic yards of material, dredged from the wrecks, the shoals abreast of Elba Island and at the Oyster Beds, and from Tybee Knoll.

Under the 22-foot project the following work has been accomplished:

At Cross Tides a dam has been constructed, extending from the rice dike on Argyle Island to that on Hutchinson Island, with the object of diverting a large volume of water at ebb tide into the Front River. This dam was originally designed to be a pile structure, and was begun in 1876. During the next year it was so much injured by a freshet that work upon it was suspended. In December, 1878, the present dam was begun. It is composed of log and brush mattresses, and brush fascines loaded with riprap stone, and is located 273 feet above the abandoned pile structure.

As soon as the dam was brought up above the level of mean low water considerable settlement occurred, due to scour caused by the ebb-tide overpour. To prevent further scour an apron of log mattresses was placed along its downstream face, and the dam was raised in 1885 with brush fascines and stone to the level of high water by building on the up-stream side of the crest, utilizing the old structure as an additional apron.

Since that time further settlement has occurred, and the work has also been damaged by fishermen and other parties who throw large quantities of stone off the dam to open a short water route from Back River to the city of Savannah.

About 70 linear feet of the old Kings Island Jetty, near Cross Tides, was removed in 1880–'81 to facilitate the flow of water into Front River.

Three wing dams were constructed in 1882–'83 for the improvement of the Garden Bank Shoal in front of the city. They spring from Fig Island and contract the waterway which was formerly from 900 to 1,050 feet in width to about 560 feet. A short spur jetty was built in 1883 about 800 feet above the lower end of Fig Island to regulate the ebb flow from Front River into the Wrecks Channel.

To properly confine the ebb currents in the Wrecks Channel a training wall rising to mean high water was built for a length of about 6,750 feet downstream from a point a little above the lower end of Fig Island, with which it is connected by a return work 160 feet in length.

This training wall, begun in 1881, and extended and raised at intervals since then, runs about parallel to the right bank of the river and is provided on the channel side with 11 short spurs placed at right angles to the axis of the channel, which has a low-water width increasing from 680 feet at the upper end to 880 feet at the lower.

Two dams, numbered 5 and 11½, respectively, and designed to increase the flow of water in the main channel, were built in 1883 to close lateral channels on either side of Barnwell Island, opposite Fort Oglethorpe.

A low-sill dam, designed to increase the ebb flow in the north channel, was built in 1881 across the south channel a short distance below the head of Elba Island.

A wing dam, numbered 15, was built in 1883 for the improvement of the channel at the Obstructions. It extends eastward from Barnwell Island, No. 3, and contracts the waterway, which was formerly about 1,950 feet in width, to about 1,000 feet.

Three pairs of wing dams have been built for the improvement of the crossing at the Upper Flats. Those numbered 4 and 23, built in 1883, constitute the upper pair and are situated at the eastern end of Spirit Island. Those numbered 6 and 25, constituting the second pair, and those numbered 10 and 27, constituting the third pair, are situated at distances below the first of about 800 and 1,600 yards, respectively.

The original low-water width of the river at this crossing varied from 2,000 to 4,000 feet. It is reduced by these dams to 1,050 feet at the upper and to 1,200 feet at the lower pair. These dams rest, with the inner ends of the respective pairs, upon opposite banks of the river, with the exception of the one numbered 27, between whose inner end and the shore there is a gap of about 500 yards.

Three wing dams have been built for the improvement of the crossing at the Lower Flats. At the upper end of this crossing, dams numbered 14 and 29 were built in 1883–'85. They spring from the opposite banks of the river, and contract the waterway from over 2,400 feet to 1,250 feet. At the lower end of this crossing a partially completed dam, numbered 13, was built in 1883. It springs from Islands 1 and 2, and leaves a waterway 1,250 feet in width between its outer end and the opposite shore of Jones Island.

The lateral channel at Philbricks Cut, Big Gap, and Dutch Gap are closed by dams built in 1882.

Two pairs of wing dams have been built for the improvement of the Long Island Crossing.

Dams numbered 26 and 33, constituting the upper pair, were built in 1885. They reduce the low-water width of the river from 3,100 to 1,300 feet. Dams numbered 28 and 35, constituting the lower pair, were built in 1886–'87 and reduce that width from 4,500 to 1,350 feet. The inner ends of these dams are connected with the shore, with the exception of number 35, between whose inner end and the shore of Jones Island there is a gap of 500 feet.

To prevent the diversion of the ebb flow from the main ship channel a dam numbered 31, and about 3,500 feet in length, was built in 1885, to close the old channel north of the Oyster Beds.

For the improvement of the channel across Tybee Knoll, a training wall extending from the Oyster Beds eastward a distance of 10,031 feet, was begun in January, 1889. Two courses were completed during that fiscal year, and during next year the third course was extended 3,660.6 feet, and an additional load of riprap was placed on the entire crest.

All of the structures described are composed of log and brush mattresses, or brush fascines, or both, loaded with riprap stone. In their original construction and the repairs which it has been necessary to execute up to July 1, 1890, there have been used 438,679.49 square yards of log and brush mattresses, 165,853.28 cubic yards of brush fascines, 95,353.58 cubic yards of riprap stone, and 1,591.87 cubic yards of shells, while 973 cubic yards of stone have been removed in repairing the Fig Island training wall.

During this period the river channel was widened at the lower end of Fig Island, and more or less dredging was done upon the various shoals between Cross Tides and Tybee Knoll. Up to July 1, 1890, the total dredged material removed, consisting of sand, mud, and shells amounted to 2,076,857.52 cubic yards.

Up to July 1, 1890, the total expenditures on Savannah Harbor by the United States since 1826, including outstanding liabilities, amounted to $1,875,219.03.

Under the present project, the following work was accomplished

prior to July 1, 1891: The Oyster Bed training wall was extended 1,984.1 feet, making its total length 12,016.1 feet. In addition to the stone used in sinking the mattresses, the crest of the training wall was heavily loaded with riprap stone, being brought up to mean low water for a distance of 7,000 feet. There were used 72,178.4 square yards of log and brush mattresses and 26,160.5 cubic yards of riprap stone.

For the protection of caving banks there were built at Elba Island 17 spur dams of piles and brush, aggregating 1,248.2 feet in length, and at Jones Island 27 similar dams, aggregating 2,845.8 feet in length. There were used in these dams 1,131 piles, 12,114.17 cubic yards of brush fascines, and 315.93 cubic yards of stone. In the closing dam at Duck Puddle, 532 feet in length, there were used 275 piles, 6,218.99 cubic yards of brush fascines, and 778.39 cubic yards of stone.

In the southern Elba Island training wall there were used 933 piles, 7,492.41 cubic yards of brush, and 40 cubic yards of stone.

There were removed by dredging from the various shoals between the Ocean Steamship Company's wharves and Tybee Knoll 396,144.66 cubic yards of material.

The total expenditures under the present project, up to July 1, 1891, including all outstanding liabilities, amounted to $277,943.49.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Jetty work under contract with Mr. John F. Gaynor was continued until August 11, 1891.

There were placed on the crest of the Oyster Bed training wall 683.77 cubic yards of stone.

The Elba Island and Jones Island spur dams were completed. There were placed in the former, 1,067.44 cubic yards of brush fascines, 134.82 cubic yards of stone; and in the latter, 5,751.41 cubic yards of brush fascines, and 546.23 cubic yards of stone. In the southern Elba Island training wall there were used 340 piles, 12,623.97 cubic yards of brush, and 570.03 cubic yards of stone. In the northern Elba Island training wall there were used 594 piles, 9,526.19 cubic yards of brush, and 353.38 cubic yards of stone.

At the ends of the Elba and Jones Island spur dams there were driven 44 clusters of fender piles.

Dredging under contract with Mr. P. Sanford Ross was continued until July 31, 1891. There were removed during that time from the channel at Tybee Knoll, 35,506.2 cubic yards of material. On the 27th and 28th of November, 1891, some lumps were dredged from the channel opposite the Savannah, Florida, and Western Railway wharves. This work was done in open market at the lowest price, the rate being the same as under the previous contract. There were removed 664.3 cubic yards of material.

CONDITION OF WORK JUNE 30, 1892.

Cross Tides.—The condition of this work is about as described in former reports. The general crest is now at an average height of 1.5 feet above mean low water.

City of Savannah.—The depth of water between the Ocean Steamship Company's wharves and the city waterworks shows no appreciable change during the year. The channel across the shoal near the upper rice mill has maintained its depth fairly well. There are considerable areas over 18 feet in depth, and the least depth in the channel is 16.2 feet at mean low water. On the Garden Bank, opposite the barge office, there is a shoal separating the 15-foot areas, and carrying

a minimum depth of 14 feet at mean low water. Some slight dredging was done at this point in November, 1891. The Garden Bank wing dams are in good condition.

Wrecks Channel.—There is a gap about 5 feet deep and 100 feet long near the lower end of the Fig Island training wall. With this exception the work is in good condition, and shows no settlement. The least depth in this channel is about 16 feet, and the 18-foot curves cover considerable areas, except near the upper end, where they disappear. No dredging has been done here during the past year.

Obstructions.—Wing Dam 15 is in good condition, but the head of Elba Island, opposite, is cutting badly. No work has been done here during the year. In the channel the 15-foot areas are separated at only one point, where a depth of 14.4 feet is found. Elsewhere the depth is from 15 to 18 feet at mean low water.

Upper Flats.—The wing dams and training walls built for the improvement of this crossing are in good condition. At the lower end of this crossing where the dredging was done in 1891, there is at one point a minimum depth of 16 feet. Elsewhere the depths exceed 18 feet at mean low water.

Lower Flats.—All of the wing dams in this locality are in good condition. In the channel the upper and lower 15-foot areas have approached each other since the year 1890, and between them is now a minimum depth of 14.2 feet at mean low water.

Long Island Crossing.—The wing dams at this crossing are in good condition. No work has been done here, but the channel has maintained its depth and the 18-foot area has slightly enlarged since 1890. The 15-foot area is continuous throughout the channel and the least depth is 15.2 feet.

Oyster Beds.—Dam 31 is in good condition. The channel at that point has been well maintained during the year.

Tybee Knoll.—The Oyster Bed training wall is in good condition. Dredging on the Knoll was suspended July 31, 1891. During that month a cut from 45 to 135 feet wide and about 3,180 feet long was dredged on the lower end of the Knoll. This cut has maintained its depth well during the year, and there is now a continuous channel whose depth exceeds 15 feet, except at the bend, where a depth of 14.5 feet at mean low water is found.

Shore protection.—Some of the spur dams built at Elba and Jones islands for the protection of the caving banks have been slightly injured by passing vessels. They have, however, been very successful, all erosion having been arrested, and the spaces between their heads are rapidly filling up with silt.

Closing dams.—All of the closing dams upon the river, with the exception of those at Philbrick Cut and Big Gap, are in good condition. Some breaks have taken place in the closing dams at Philbrick Cut and Big Gap, which, when completed, were at the level of mean high water. A great deal of stone has been thrown off those dams by negro fisherman to open a waterway through into the South Channel, and these small gaps have rapidly enlarged under the influence of storms. All of the other closing dams are in good order, although they have settled slightly in some cases.

COMMERCE AND NAVIGATION.

A full statement and discussion of the commerce of Savannah were given in my last annual report, to which I respectfully refer for details in this connection.

The railroads now centering in Savannah are the Charleston and Savannah, the South Bound, the Central of Georgia, the Savannah, Americus and Montgomery, and the Savannah, Florida and Western. Railroads under construction are the Macon and Atlantic, the Middle Georgia and Atlantic, and Macon and Dublin.

In addition to the railroads the Savannah River, navigable as far as Augusta, a distance of 202 miles by the river, for boats drawing from 4 to 5 feet, affords another means of communication with the interior, and a number of small steamers and sailing craft ply the waters of the inland route, along the adjacent coast, gathering the products of the sea and of the coast plantations for trans-shipment at Savannah.

These avenues of commerce bring to Savannah the cotton, lumber, naval stores, and farm and mineral products of large portions of the States of Georgia, South Carolina, Florida, Alabama, and Tennessee, as well as other classes of through freights from the west and northwest.

Regular lines of steamships have been established between this port and Boston, New York, Philadelphia, and Baltimore. These lines comprise a total of 12 steamships, of which 7 are to New York, 2 to Boston, 2 to Baltimore, and 1 to Philadelphia. They make yearly more than 400 voyages and carry about 673,000 tons of freight.

During the past year nearly 100 foreign steamships, with an aggregate tonnage of 125,000 tons, have cleared from Savannah for foreign ports with cargoes of cotton and naval stores.

On the inland waters there are seven small steamers plying between Savannah and adjacent ports, making annually from 500 to 600 trips and carrying about 60,000 tons of freight, valued at over $4,000,000.

The steamships mentioned above carry nearly one-half of the exports from Savannah. A larger portion is carried by sailing vessels, of which there are annually about 525 clearances, with an aggregate tonnage of about 260,000 tons. Of these the American vessels number 312, with a tonnage of about 132,000, and the foreign vessels number 213, with a tonnage of 128,000. Practically all of the foreign trade is carried in foreign bottoms.

The chief articles of export are cotton, lumber, and naval stores, of which the present annual shipments may be given in round numbers, as follows: Of cotton, 1,140,000 bales; of lumber, over 100,000,000 feet; and of naval stores, 196,000 barrels of turpentine and 770,000 barrels of rosin.

There are also large shipments of fruits and vegetables to northern ports aggregating over 1,000,000 packages annually, and some of the phosphate rock from the Florida mines is seeking an outlet to foreign ports at Savannah.

The total annual tonnage of the port, inward and outward bound, is over 2,000,000 tons, and the annual value of the exports alone is, in round numbers, $84,000,000. The total annual value of the commerce of Savannah is about $153,000,000.

Past improvement of the harbor has resulted in increasing the available depth at high water from 14.5 feet to from 21 to 22 feet. The increase in the value of exports since the year 1873, when the work was begun, is proportional to the cube of the increase in the depth of water during the same period. If the same proportion should hold till a depth of 26 feet is reached, the value of the exports alone would then be about $150,000,000. The annual saving in freight rates alone, due to the increased depth, amounts to more than the total sum of money expended

by the United States upon the harbor. Rates of marine insurance have also been reduced.

TABLE I.—*Cotton receipts at Savannah from 1872 to 1891.*

Season, August 31 to September 1—	Number bales.	Season, August 31 to September 1—	Number bales.
1872-'73	612,794	1882-'83	817,670
1873-'74	630,372	1883-'84	655,749
1874-'75	614,478	1884-'85	728,087
1875-'76	523,244	1885-'86	803,359
1876-'77	477,435	1886-'87	804,412
1877-'78	597,449	1887-'88	892,318
1878-'79	693,764	1888-'89	828,168
1879-'80	741,018	1889-'90	956,517
1880-'81	889,383	1890-'91	1,139,560
1881-'82	737,056		

TABLE II.—*Steamship lines.*

Lines.	Savannah to—	Steamers.	Voyages.	Freight.
Ocean Steamship Co	New York	7	221	471,393
New England and Savannah Steamship Co*	Boston	2	56	91,112
Merchants and Miners Transportation Co	Baltimore	2	98	75,426
Ocean Steamship Co	Philadelphia	1	34	35,122
Total		12	409	673,053

* Controlled by Ocean Steamship Company.

MISCELLANEOUS.

The work is located in the collection district of Savannah, Ga. Savannah is the port of entry. Amount of duties collected in 1891, $56,714.50. The nearest light-houses are those upon the river, and Forts Oglethorpe and Pulaski are the nearest forts.

It is desired again to invite attention to the fact that the work has not progressed satisfactorily, and that its cost has been much increased owing to irregular and inadequate appropriations. Future operations should be carried on simultaneously throughout the whole extent of the river, and to secure successful and permanent results, dredging should be accompanied or promptly followed by contracting works. To secure the fullest benefits from the improvements already executed and in order that the future growth of the port may not be seriously retarded, it should be enabled to furnish an outlet for the rapidly growing commerce brought from the interior. It is proposed to expend any funds which may become available during the year in the construction of training walls and in dredging, as provided for in the project for securing a depth of 26 feet at mean high water.

A vigorous and an economical prosecution of the work will be possible only with regular and adequate appropriations. The insufficient and irregular appropriations of the past have rendered satisfactory progress impossible and have increased the cost of the work in some instances as much as 100 per cent. The sum asked for during the next fiscal year is $1,000,000. The most desirable and satisfactory results can not be obtained with an expenditure during the year of a less amount.

Since the existing project for improving Savannah Harbor was adopted one appropriation of $350,000 has been made and an unexpended balance of $4,035.05 transferred from a former appropriation.

The total expenditures under the present project to June 30, 1892, including all outstanding liabilities, were $346,377.80.

Money statement.

July 1, 1891, balance unexpended	$141,886.14
June 30, 1892, amount expended during fiscal year	133,322.39
July 1, 1892, balance unexpended	8,563.75
July 1, 1892, outstanding liabilities	906.50
July 1, 1892, balance available	7,657.25
Amount appropriated by act approved July 13, 1892	318,750.00
Amount available for fiscal year ending June 30, 1893	326,407.25
Amount (estimated) required for completion of existing project	2,831,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Cotton statistics of the port of Savannah, Ga., for the commercial year ending August 31, 1891.

[Compiled by J. P. Merrihew, superintendent Cotton Exchange.]

Receipts from all sources.	Quantity.	Weight.	Value.
	Bales.	*Pounds.*	
Upland	1,093,978	540,066,938	$52,445,005
Sea Island	45,630	18,298,542	3,723,408
Total	1,139,608	558,365,480	56,168,413

Exports from Savannah.	Upland.	Sea Island.
	Bales.	*Bales.*
Coastwise	517,373	21,348
Great Britain	106,395	20,062
France	35,423	2,172
Other continental ports	433,544	200
Mill consumption and burnt	1,961	....
Reshipped to interior	600	....
Total	1,095,296	43,782

Total exports, etc.	Quantity.	Weight.	Value.
	Bales.	*Pounds.*	
Upland	1,095,296	540,737,635	$52,508,890
Sea Island	43,782	17,557,457	3,572,611
Total	1,139,078	558,305,092	56,081,501

Foreign exports:
Upland ....bales.. 577,023
Sea Island ....do... 22,434

Coastwise exports:
Upland ....bales.. 517,373
Sea Island ....do... 21,348

Average value per bale:
Upland $47.94
Sea Island 81.60

Average weight per bale:
Upland ....pounds.. 493.52
Sea Island ....do.... 401.02

Arrival and clearance of vessels and commerce at Savannah, Ga., from January 1, 1873, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	*Feet.*
1873...	463	381,595	11,934	34	16,140	383	213	119,316	2,999	710	517,051	15,316	17.50
1874...	418	354,700	10,048	66	41,030	847	281	182,517	4,232	768	578,247	15,127	17.50
1875...	370	310,877	10,102	67	39,832	781	222	145,748	3,290	659	495,923	14,173	17.50
1876...	355	320,015	10,348	58	40,298	987	260	160,640	3,865	673	530,496	15,200	17.75
1877...	333	379,826	10,867	54	40,948	951	287	168,247	3,950	674	589,021	15,768	18.25
1878...	322	385,532	10,688	61	45,208	576	326	235,787	5,814	709	666,527	18,078	18.50
1879...	319	414,704	8,235	30	21,994	1,576	279	198,040	3,960	628	634,828	12,634	17.75
1880...	338	446,881	9,906	14	7,724	439	244	172,224	3,533	596	626,829	13,699	18.33
1881...	383	508,422	11,069	21	10,729	170	254	151,463	3,474	658	670,614	14,780	19.00
1882...	391	544,488	12,605	11	4,865	237	204	115,061	2,718	606	666,374	16,429	19.00
1883...	380	468,226	10,659	10	4,115	106	160	87,020	1,965	550	559,366	12,714	18.25
1884...	388	482,917	13,735	14	5,632	90	287	174,676	3,984	689	663,225	17,835	19.00
1885...	395	493,610	14,622	12	5,058	116	251	163,321	3,416	658	668,980	18,163	20.75
1886...	393	503,073	14,534	10	5,952	125	268	177,229	3,719	671	686,254	18,438	20.00
1887...	430	543,235	15,127	8	2,725	185	231	130,136	2,800	669	676,096	17,987	20.40
1888...	411	539,576	14,907	8	3,560	60	229	146,075	3,288	648	689,211	18,306	20.67
1889...	409	561,463	15,547	12	6,563	111	309	215,865	4,530	730	783,891	20,231	20.70
1890...	483	717,561	19,178	9	2,303	69	300	193,263	4,058	792	913,217	23,305	20.00
1891...	484	719,328	19,014	13	4,778	123	325	238,123	4,790	822	962,229	23,927	20.00

CLEARED.

1873...	466	398,050	13,749	65	30,102	660	224	129,164	3,194	755	557,316	17,632	17.50
1874...	480	407,295	12,748	71	40,397	822	229	145,038	3,437	780	592,730	17,007	17.50
1875...	319	234,831	9,376	72	39,311	804	195	128,086	2,924	586	452,228	13,104	17.50
1876...	410	361,999	11,222	80	49,483	1,163	185	119,699	2,827	675	531,781	15,212	17.75
1877...	400	439,370	12,081	65	44,829	1,066	161	103,342	2,489	626	587,541	15,736	18.25
1878...	378	418,958	10,475	64	40,128	1,255	260	183,757	5,375	702	642,843	17,105	18.50
1879...	365	442,734	8,834	36	24,891	497	223	156,470	3,129	624	624,095	12,460	17.75
1880...	310	434,864	10,108	26	12,536	271	242	168,255	3,446	578	615,655	13,825	18.33
1881...	369	508,422	11,458	22	13,052	253	261	180,579	3,745	652	702,053	15,456	19.00
1882...	350	506,213	11,917	23	9,155	205	209	135,375	3,023	582	650,743	15,145	19.00
1883...	355	415,720	9,780	10	4,115	90	165	87,400	2,015	530	507,235	11,885	18.25
1884...	360	452,802	13,363	15	5,634	131	288	194,075	4,315	663	652,411	17,809	19.00
1885...	414	502,773	14,672	20	8,722	148	228	154,858	3,344	662	666,353	18,164	20.17
1886...	378	473,134	13,912	3	039	24	262	194,793	3,970	643	668,867	17,906	20.00
1887...	380	480,030	14,167	4	678	29	269	202,656	4,186	653	683,364	18,382	20.00
1888...	382	507,075	14,231	8	2,583	63	233	167,836	3,557	623	677,494	17,851	......
1889...	395	540,293	15,505	7	1,323	51	307	226,181	4,601	711	767,747	20,157	......
1890...	452	663,227	18,815	14	4,087	161	323	248,013	5,078	789	915,327	24,054	20.75
1891...	445	676,900	18,200	4	9,909	208	339	271,067	5,429	788	957,876	23,837	20.75

T. F. JOHNSON,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

COMMERCE.

Years.	Value of exports.	Value of imports.	Duties collected.	Years.	Value of exports.	Value of imports.	Duties collected.
1877..........	$32,103,853	$36,307,908	$34,959.93	1885..........	$48,313,216	$49,881,080	$45,161.40
1878..........	40,028,988	42,948,465	23,364.35	1886..........	51,033,190	51,118,524	35,455.53
1879..........	40,901,421	43,064,472	27,778.73	1887..........	54,774,082	52,659,223	48,837.12
1880..........	47,836,411	45,522,480	78,458.41	1888..........	56,435,601	53,412,920	98,213.75
1881..........	58,985,901	48,716,900	356,550.22	1889..........	62,892,429	55,062,710	58,815.54
1882..........	52,004,248	45,952,105	61,148.70	1890..........	84,584,326	68,229,825	57,542.57
1883..........	53,915,934	47,690,796	65,245.34	1891..........	83,367,157	67,248,000	56,714.50
1884..........	46,425,513	49,112,316	49,147.28				

N 2.

IMPROVEMENT OF SAVANNAH RIVER, GEORGIA.

The Savannah River is formed by the junction of the Tugaloo and Keowee, and flows in a southeasterly direction to the sea.

A detailed description of this river is found in my report of the examination and survey of the portion above Augusta, printed as House Ex. Doc. No. 213, Fifty-first Congress, first session, and in my report of the survey of the river between Augusta and Savannah, dated June 30, 1890, and printed as Appendix O 2, Annual Report of the Chief of Engineers for 1890, pages 1328–1363.

For a special history of past work see page 1029, Annual Report of the Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 4 to 5 feet of water, but during the low-water season there are various shoals in the upper portion of the river with low-water depths of not more than about 3 feet. The chief obstruction to navigation consists of sand and gravel bars, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of June 30, 1890, provides for the establishment of a navigable steamboat channel 5 feet deep at ordinary summer low water between the cities of Augusta and Savannah.

This is to be accomplished by (1) removing sand and gravel bars; (2) regulating portions of the river, revetting caving banks, and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated in round numbers at $332,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

The first appropriation ever made for the Savannah River was expended on a snag boat built for use upon this river and the Altamaha. This boat began work upon the river on February 17, 1882, and has been employed at intervals since that date, continuous work having been impossible on account of insufficiency of funds. Irregular and inadequate appropriations have prevented the selection of the most suitable seasons for doing work. Then, too, the boat has been tied up for months at a time in a climate where decay is very rapid. As a result numerous and costly repairs have had to be made which would not have been needed had the boat been kept in commission. In 1889 the boat had become rotten and unserviceable and was rebuilt at Abbeville, Ga., under contract with Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., and outfitted at Savannah. In all the boat was employed 685 days upon the river between Augusta and Savannah, removing during that time 1 sunken steamboat, 82 piles, 1,578 snags, logs, and stumps, and

4,935 overhanging trees, besides a number of wrecked flats and a number of other minor obstructions. Many of the obstacles were very large and troublesome, and their removal without a suitable snag boat would have been impossible.

In 1883–1885 wing dams, projecting from the South Carolina bank, were built for the improvement of Gardner Bar, opposite the city of Augusta, contracting the low water way from 650 to 350 feet. In the same year shore protection aggregating in length 1,375 feet was put in at eight different points along the city front. Since then contracting works have been constructed at Course Bar, Sand Bar Ferry, and Blue House Bar, situated 2, 4, and 6 miles, respectively, below the city of Augusta.

At Course Bar 7 wing dams have been built, 3 on the right bank and 4 on the left, reducing the low-water way from 650 to 350 feet. At Sand Bar Ferry 5 wing dams were built, 1 on the right bank and 4 on the left, reducing the low-water way from 650 to 400 feet, and in 1889 two additional wing dams were constructed on the right side of the river and the old work was raised and repaired, reducing the low-water width to 350 feet.

At Blue House Bar 7 wing dams were built, 4 on the right bank and 3 on the left, reducing the width of the low-water way from 650 to 400 feet. In 1889, the channel having shifted, a new dam, 580 feet long, was constructed, springing from the right bank, and three additional short spurs were built on the left bank. Portions of the old dams were removed and the resulting low-water channel was 350 feet in width.

These various works have been built of brush fascines, loaded with gravel and riprap stone. In their construction there have been used a total of 17,619.61 cubic yards of brush fascines and 9,424.09 cubic yards of gravel and stone.

All work, with the exception of that done by the snag boat, has been done by contract.

Up to July 1, 1891, the total expenditures for the work, including outstanding liabilities, amounted to $100,891.43, including $2,500 received from other appropriations for use of snag boat.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Active operations during the fiscal year consisted in constructing, under contract of September 9, 1891, with Mr. John F. Gaynor, 7 spur dams of brush fascines and stone for the protection of the caving banks on the Georgia side of the river below the city of Augusta and in repairing some of the old dams at Gardner Bar, Course Bar, and Sand Bar Ferry. The caving of the banks threatened to widen the river excessively at this point, and large quantities of the eroded material were deposited on the troublesome bars below to their serious detriment. The work done has thus far successfully prevented further damage of this nature. Work was begun October 5 and ended November 20, 1891, the funds available having been exhausted. There were used in the new dams 2,179.25 cubic yards of brush fascines and 1,382.73 cubic yards of stone, and in the repairs to the old dams, 2,682.15 cubic yards of brush fascines and 1,969.73 cubic yards of stone, making a total of 4,861.4 cubic yards of fascines and 3,352.47 cubic yards of stone.

CONDITION OF WORK JUNE 30, 1892.

The depth of water along the city wharves at Augusta is ample. The spur dams at Gardner Bar, opposite the city, are now in good

condition, the breaks in them having been repaired during the past year and their crests raised to a uniform height of about 2 feet above summer low water. The spurs designed to protect the river bank below the city of Augusta are in good condition and have thus far accomplished their purpose. Two of the dams at Course Bar and two at Sand Bar Ferry were also repaired and brought to a height of about 2 feet above low water during the past year. All the dams at these points are now in good condition and the depth of water on the shoals is about 6 feet. The dams at Blue House Bar remain as described in my last annual report. Though damaged to some extent, they still fulfill their object and maintain a sufficient depth on the shoal. At the Port Royal and Augusta Railway bridge the main current and best channel pass to the left of the draw opening, thus rendering it difficult for boats to pass through, since their approach is at an angle with the direction of the current.

No snags have been removed during the past fiscal year. A freshet, which reached a height at Augusta of 36.7 feet on the gauge, and a long period of high water have occurred since snagging operations were suspended, bringing into the river a number of snags and logs that should now be removed.

COMMERCE AND NAVIGATION.

A detailed statement of the sources whence the commerce of this river is derived, of its value, and of the probable effect of the completion of the works of improvement is given in my report on the survey of the river, dated June 30, 1890, and printed as part of Appendix O 2, Annual Report of the Chief of Engineers for 1890.

Prior to the inauguration of the works of improvement the commerce of the river, especially in the way of through shipments, was unimportant, as the condition of the channel rendered navigation uncertain and unsafe.

The improvement of the river has been accompanied by a steady increase in the volume of river traffic and by a decrease in the rates of freight, both of which are more than commensurate with the expenditures involved. In fact, the annual commerce has increased at the rate of $10 for every dollar expended by the United States and freight rates have been reduced about 20 per cent.

The exports from the river valley are mainly cotton, naval stores, lumber, and wood, while the imports are fertilizers, camp and mill supplies, cotton-ties and bagging, and manufactured articles. Three or four steamers are engaged in the river traffic, carrying annually about 39,000 tons of freight, valued at $2,340,000. In addition to the freights carried by the various steamers, the river valley affords logs, hewn and sawed timber, spars, and cord wood. The timber is rafted down the river. A large portion of the cord wood is lightered to Savannah, while the remainder is used as fuel by the river boats. The hard wood sawed and the shingles split along the river are shipped to Savannah by boat. It is estimated that about 23,000 tons of logs, timber, and cord wood, valued at about $80,000, are annually rafted or lightered to Savannah and other places along the river. This makes the total annual shipments of the Savannah River 62,000 tons, valued at $2,420,000.

It is almost impossible to obtain accurate statements of the annual commerce on the river, as the figures furnished by the steamer agents are nothing more than estimates, and those who might and ought to

be able to collate and furnish satisfactory and true figures seem disinclined to do so. It is believed that the figures herein given, when not specific, are close approximations to the true values.

MISCELLANEOUS.

The work is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collected in 1891, $56,714.50. Forts Oglethorpe and Pulaski are the nearest forts and the nearest light-houses are those upon the river below Savannah.

Since the existing project for improving the Savannah River was adopted one appropriation of $25,000 has been made and an unexpended balance of $19.91 transferred from a former appropriation.

The total expenditures under the present project up to June 30, 1892, including all outstanding liabilities, were $24,076.75.

It is proposed to expend any available funds and any funds that may become available during the year in the removal of obstructions, in the construction of works of shore protection, and in the improvement of shoals in the river, according to the plan contained in my report of June 30, 1890.

The sum of $75,000 can be advantageously and economically expended during the coming year.

No permanent improvement can be effected, as new obstructions, caused by snags and logs, form during every high-water season. They should, however, become fewer in number each year. From $3,000 to $5,000 will be required for the annual maintenance of the completed work.

Money statement.

July 1, 1891, balance unexpended	$17,608.67
June 30, 1892, amount expended during fiscal year	16,665.51
July 1, 1892, balance unexpended	943.16
Amount appropriated by act approved July 13, 1892	35,000.00
Amount available for fiscal year ending June 30, 1893	35,943.16
Amount (estimated) required for completion of existing project	272,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing and repairing wing dams and shore protection in the Savannah River below Augusta, Ga., opened on August 1, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price for— Mattresses.	Stone.
		Cu. yd.	*Cu. yd.*
1	Jacob Friday, Charleston, S. C	$1.61	$3.15
2	Samuel W. Skinner and Thomas E. Wallace, Wilmington, N. C	2.10	3.10
3	John F. Gaynor*, Fayetteville, N. Y	1.29	2.60

*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable services.

Amount available, about $15,000.

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., February 15, 1892.

CAPTAIN: I have the honor to submit the following report of snagging operations on the Savannah River, Ga., for the fiscal year ending June 30, 1892:

No snag work has been done since June 1, 1891, on account of lack of funds, and there are still large numbers of troublesome obstructions, which were especially so for some weeks this last fall, when the river was at its lowest stage.

A number of complaints has been made by steamboat men; but in some cases they were due to the exceptionally low water. The master of the steamer *Katie* stated that he reached the clay reef below Canoe Gut (194), but could not pass it. Heretofore steamboats have passed this, but were troubled by shoal water above Canoe Gut.

Kings Creek (114–116) will need continuous attention for some time or until it is of sufficient size to carry the full volume of the river. Every year the old river becomes shallower and a corresponding increase is made in the volume carried by Kings Creek. The result is a continuous caving-in of Kings Creek and continuous work for the snag boat.

When work is resumed, the snag boat should remove the worst obstructions over the entire length of river and then devote attention to the bad localities. A list of such places can be made while making the first run.

The only accident due to snags was the sinking of the *Katie* at Bay Bush Point (31), and in this case the boat was not in its usual channel.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 3.

IMPROVEMENT OF DARIEN HARBOR, GEORGIA.

About 12 miles above the town of Darien, the Altamaha River divides into several branches. The northerly main branch forms the Darien River. That portion of Darien River between Darien and Doboy Sound is known as Darien Harbor.

Operations for improving this harbor have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by Gen. Gillmore, the officer then in charge, dated January 30, 1885, and printed as Appendix N 16, Annual Report of the Chief of Engineers for 1885.

ORIGINAL CONDITION.

Darien Harbor is at seven points and, covering a total distance of 9.7 miles, more or less obstructed by shoals with minimum low-water depths on them of from 6.3 to 10.6 feet. The reaches between these shoals have nowhere less than 12 feet depth at mean low water. The mean rise and fall of tide in the river are about 6.5 feet.

PLAN OF IMPROVEMENT.

The plan of improvement contemplates the establishment of a navigable channel between Darien and Doboy with a minimum low-water depth of 12 feet. This is to be accomplished by dredging to a minimum depth of 12.5 feet and by the construction of wing dams at five of the shoals for maintaining the depth of the improved channel.

The estimated cost of the improvement is $170,000.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

Five of the shoals at Darien Harbor were temporarily improved by dredging, in 1879, by means of an appropriation of $8,000, made by act of Congress approved June 18, 1878.

The first work under the present project was done under a contract for dredging executed on May 5, 1891, with Mr. P. Sanford Ross. Work was begun June 11, 1891, at Shoal No. 3, below Pico Cut. There were removed up to July 1, 1891, 13,194.6 cubic yards of material.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Dredging under the existing contract with Mr. P. Sanford Ross was continued until November 13, 1891, when the funds available for the work were exhausted.

There were removed during the year from the various shoals 73,445.6 cubic yards of material.

CONDITION OF WORK JUNE 30, 1892.

When dredging was discontinued, November 13, 1891, cuts had been made through four of the shoals in the harbor. The excavation was carried to an average depth of 12 feet at mean low water. An examination of these cuts was made during the month of May, 1892. At Shoal No. 4 the cut was 536 feet long and 60 feet wide. Its depth is now from 10.5 to 12 feet at mean low water. At Shoal No. 3 a cut about 2,700 feet long, and from 30 to 90 feet wide, was dredged. The depths here have held fairly well and vary from 10 to 12 feet. A number of logs were found in and near the channel. The cut at Shoal No. 2 is 1,700 feet long and from 30 to 60 feet wide. In this cut the depth is now nowhere less than 11 feet at mean low water. At Shoal No. 1½ a single cut 30 feet wide and 2,993 feet long was excavated. Its depth is now from 11 to 13 feet throughout. There were formerly on these shoals depths of from 7 to 9 feet.

COMMERCE AND NAVIGATION.

The commerce of Darien is entirely dependent upon water carriage, It consists principally of shipments of lumber, timber, naval stores. and rice, which are brought down the Altamaha from the region bordering that river and its tributaries. But little cotton seeks an outlet at this port. The total annual trade amounts to about 125,000 tons, valued at $1,500,000, the freight on which is about $600,000.

The outlet of Darien Harbor is by way of Doboy and Doboy Bar, but the shoaling of the latter renders the entrance of deep-draft vessels impossible, and much of the timber that would otherwise be shipped from Darien is now rafted to Sapelo and St. Simons, at an increased cost of about 25 cents per 1,000 feet. These shipments, amounting annually to about 20,000,000 feet, are not included in the Darien exports, although it all passes through the harbor.

There is also a large number of small sailing craft carrying rice, fish, vegetables, etc., plying on the inland waters around Darien, and on the inland route there are two steamers per week to Savannah and eight steamers per week to Brunswick.

MISCELLANEOUS.

The work is situated in the collection district of Brunswick, Ga. Darien is the nearest port of entry. Duties collected in 1891, none. Sapelo Light is the nearest light-house and Forts Oglethorpe and Pulaski are the nearest forts.

By act of Congress approved June 18, 1878, an appropriation of $8,000 was made for this work.

Since the existing project for the improvement of Darien Harbor was adopted, in 1885, one appropriation of $25,000 has been made for this work. The total expenditures under the present project of improvement to June 30, 1892, including all outstanding liabilities, were $24,321.97.

It is proposed to expend the funds on hand and any that may become available during the year in the removal of the shoals by dredging and in the construction of works of contraction in accordance with the existing project.

The sum of $100,000 can be economically and advantageously expended during the coming year.

Money statement.

July 1, 1891, balance unexpended	$23,164.27
June 30, 1892, amount expended during fiscal year	22,431.24
July 1, 1892, balance unexpended	733.03
July 1, 1892, outstanding liabilities	55.00
July 1, 1892, balance available	678.03
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	25,678.03
Amount (estimated) required for completion of existing project	120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Arrivals and clearances of vessels at Darien, Georgia, from Jaunary 1, 1875, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports. American vessels.			Foreign ports. Foreign vessels.			Total.			Greatest draft.
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	Ft.
1875	77	28,053	647	...	...	...	92	47,600	1,198	169	75,663	1,845	22
1876	65	23,105	611	...	...	...	124	70,368	1,897	189	93,473	2,508	21
1877	104	24,827	1,257	3	674	22	99	50,913	1,231	206	106,414	2,510	20
1878	61	29,264	641	2	1,051	20	126	60,109	1,628	189	90,424	2,289	20
1879	58	23,275	487	3	1,199	25	115	57,710	1,407	176	82,184	1,919	19½
1880	66	21,539	489	1	688	13	134	68,072	1,608	201	90,270	2,140	19½
1881	101	40,619	849	3	1,220	29	102	84,457	1,991	166	126,295	2,869	19½
1882	117	48,208	999	1	453	9	90	51,421	1,155	208	100,082	2,163	19
1883	95	38,173	815	...	...	...	93	49,290	1,135	188	87,903	1,950	19
1884	81	34,412	714	2	606	16	92	50,178	1,133	175	85,193	1,863	19
1885	78	27,763	691	2	652	16	80	42,587	975	160	71,002	1,673	18½
1886	108	44,389	852	...	...	...	42	20,772	483	150	65,161	1,335	19
1887	127	57,035	1,059	5	2,349	45	26	13,023	298	158	72,407	1,402	...
1888	185	76,645	1,558	1	402	9	22	13,423	273	208	91,470	1,840	18½
1889	145	69,763	1,341	7	4,349	62	61	19,837	453	213	93,949	1,856	13½
1890	169	58,058	1,158	5	1,964	41	28	1,086	308	202	61,108	1,507	18½
1891	137	56,818	1,124	6	2,377	46	24	17,853	308	167	77,048	1,478	...

Arrivals and clearances of vessels at Darien, Georgia, etc.—Continued.

CLEARED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	Ft.
1875	22	12, 214	328	11	4, 055	97	104	55, 759	1, 372	137	72, 028	1, 797	22
1876	39	9, 300	270	4	1, 553	32	180	87, 489	2, 263	223	98, 342	2, 565	21
1877	44	13, 209	314	4	842	21	169	92, 795	2, 154	217	106, 846	2, 489	20
1878	28	7, 842	181	6	3, 000	62	149	83, 385	1, 947	183	94, 236	2, 190	20
1879	40	14, 052	301	7	2, 765	57	125	65, 433	1. 538	172	82, 250	1, 896	19½
1880	55	17, 076	393	7	3, 589	72	168	84, 172	2, 016	230	194, 837	2, 481	19½
1881	80	28, 492	617	8	3, 120	70	184	95, 353	2, 164	272	126 965	2, 851	19½
1882	93	34, 098	709	6	1, 962	46	115	63, 525	1, 434	214	99, 585	2, 189	19
1883	66	25, 019	510	9	3, 533	72	108	56, 411	1, 340	183	84, 963	1, 931	19
1884	59	20, 637	457	11	3, 977	85	119	66, 337	1, 478	189	90, 951	2, 020	19
1885	46	16, 649	339	8	3, 354	62	98	52, 742	1, 198	152	72, 745	1, 599	18½
1886	93	38, 295	719	10	3, 682	80	50	24, 376	564	153	66, 358	1, 363	19
1887	126	55. 592	1, 016	12	1, 144	17	16	8, 612	189	144	65, 700	1, 222	....
1888	155	64, 749	1, 318	2	538	15	36	23, 742	453	193	89, 029	1, 786	19
1889	155	63, 347	2, 091	6	4, 333	66	46	26, 488	528	207	94, 168	2, 685	....
1890	171	58, 810	1, 174	3	972	23	31	15, 569	336	205	75, 351	1, 533	....
1891	127	53, 890	1, 031	3	896	20	26	18, 006	256	156	72, 792	379	....

Timber shipments from port of Darien, Ga., from January 1, 1875, to December 31, 1891.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
1875	41, 447, 024	$557, 524	10, 992, 600	$181, 377. 00	52, 439, 624	$738, 901. 00
1876	60, 762, 000	735, 099	8, 370, 000	138, 105. 00	69, 132, 000	873, 204. 00
1877	64, 378, 000	776, 856	11, 888, 100	196, 153. 65	76, 266, 100	973, 009. 65
1878	59, 697, 124	716, 365	7; 057, 800	116, 453. 70	66, 754, 924	832, 818. 70
1879	47, 217, 818	566, 613	12, 646, 800	208, 672. 20	59, 804, 618	775, 285. 20
1880	74, 612, 520	895, 350	15, 368, 500	253, 578. 60	89, 981, 020	1, 148, 928. 60
1881	65, 420, 876	785, 050	25, 642, 800	423, 106. 20	91, 063, 676	1, 208, 156. 20
1882	36, 639, 379	439, 672	30, 688, 200	506, 355. 30	67, 327, 579	946, 027. 30
1883	42, 385, 000	508, 620	22, 517, 100	371, 532. 15	64, 902, 100	880, 152. 15
1884	50, 656, 000	607, 872	18. 573, 300	306, 459. 45	69, 229. 300	914, 331. 45
1885	40, 101, 000	501, 262	14, 984, 100	247, 937. 65	55, 085, 100	749, 199. 65
1886	19, 960, 000	219, 500	24, 465, 000	661, 440. 00	54, 425, 000	870, 940. 00
1887	12, 023, 611	138, 476	50, 349, 600	912, 220. 00	62, 373, 211	1, 056, 960. 00
1888	17, 975, 371	215, 705	65, 998, 200	1, 121, 960. 00	83, 975, 571	1, 337, 665. 00
1889	20, 772, 265	237, 652	50, 667, 660	760, 144. 00	71, 449, 865	997, 816. 00
1890	10, 962, 017	140, 746	68, 223, 683	949, 762. 00	79, 185, 700	1, 090, 508. 00
1891	13, 785, 333	274, 674	45, 519, 707	910, 718. 10	59, 305, 040	1, 185, 391. 80

Commerce.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1, 621, 904	$5, 600	$11, 806. 72
1881	1, 137, 490	3, 356	18, 980. 02
1882	1, 073, 008	1, 025	11, 254. 19
1883	969, 834	2, 334	11, 067. 37
1884	1, 038, 185	11	9, 688. 20
1885	860, 500	....	2, 359. 01
1886	1, 037, 330	....	....
1887	1, 221, 000	....	....
1888	2, 100, 000	2, 600	964. 13
1889	997, 816	None.	None.
1890	140, 746	None.	None.
1891	1, 530, 000	None.	None.

C. LAWTON,
Deputy Collector, Darien, Georgia.

N 4.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

The Altamaha River is formed by the junction of the Oconee and Ocmulgee rivers, in the southeastern part of Georgia, and flows in a southeasterly direction to the sea.

A detailed description of this river is given in my report of a survey, dated June 12, 1890, which is printed as part of Appendix O 5, Annual Report of the Chief of Engineers for 1890, pages 1372–1386.

For a special history of past work see page 1038, Annual Report of the Chief of Engineers for 1888 and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

The chief obstruction to the navigation of the Altahama River consists in rock ledges, sand bars, overhanging trees, snags, and sunken logs. The rock ledges were confined to the upper portion of the stream, while the other obstructions were found throughout its entire course. The low-water depths at some points did not exceed 1 foot.

PLAN OF IMPROVEMENT.

The plan of improvement outlined in my report of June 12, 1890, provides for the establishment of a navigable steamboat channel, 3 feet deep at ordinary summer low water, between the junction of the Oconee and Ocmulgee rivers and the town of Darien.

This is to be accomplished by (1) removing rock shoals and sand bars; (2) building deflecting dikes and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream; (4) revetting caving banks.

The cost of the improvement is estimated in round numbers at $129,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

The first appropriation ever made for the Altamaha ($5,000) was expended on a snag boat, which was built for use upon this river and the Savannah. This boat began to work upon the river on October 1, 1883, and has been employed at intervals since that date, regular work having been impossible on account of the insufficiency of funds. She was thoroughly repaired in 1889. Operations have been carried on between Darien and the junction of the Oconee and Ocmulgee rivers. There have been removed in all 2 piles, 1,256 snags and logs, and 2,628 overhanging trees; 16 logs were cut up on bank, 5 trees were deadened, and 4 trees pulled back.

In 1883 channels 100 feet in width and 4 feet in depth at ordinary low water were opened through the rock ledges at Town Bluff and Piney Bluff by the removal of 319 and 1,480 cubic yards of rock at these points, respectively.

In 1884–'85 a training wall was built at Beards Bluff for the improvement of a shoal at that locality, and shore protection was constructed for the protection of caving banks. In the execution of this work 811.2 cubic yards of stone, 428.44 cubic yards of gravel, and 3,545.38 cubic yards of brush fascines were used.

All work, with the exception of that done by the snag boat, was done by contract.

Up to July 1, 1891, the total expenditures for this work, including outstanding liabilities, amounted to $67,223.38.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

The snagboat *Toccoa* continued operations on the river until August 31, 1891, when she was transferred to the Ocmulgee River. It was intended to resume snagging operations on January 15, when the boat returned, but the high water compelled the suspension of work. There were removed 521 snags and stumps and 1,011 overhanging trees. In addition 8 logs were cut up on the river bank.

The steam hoister, rigged as a pile-driver, began work October 26, 1891, at Beards Bluff, in the construction of wattled pile spur dams and in repairing the old training wall for the improvement of the sand bar at that point. Operations were suspended at the end of January, 1892, owing to high water, but were resumed May 5 and are still in progress, the work being nearly completed. In this work 239 piles have been driven, 1,914 linear feet of piling have been wattled with poles, 1,231 linear feet of brush mattresses 18 feet wide have been sunk and covered with 141 cubic yards of stone, and the banks at the ends of the ten dams constructed have been cut down and protected with brush and stone.

CONDITION OF WORK JUNE 30, 1892.

A detailed description of the condition of the river, containing a statement of the localities needing improvement, is given in my report of June 12, 1890. The river is now in a better condition than it has ever before been. The most dangerous obstructions, due to snags and overhanging trees, have been removed, and the work accomplished at Beards Bluff during the past year has increased the depth on that bar by from 2 to 3 feet. Boats were formerly compelled at low water to partially unload and lighter their cargoes across this bar. They can now pass without difficulty.

Work is now most needed at Marrow Bone Bar and at the rock shoals on the upper portion of the river.

COMMERCE AND NAVIGATION.

The commerce passing over the Altamaha River is derived not only from the region bordering it, but also from the country bordering its tributaries, the Ocmulgee and the Oconee rivers.

About one-half of the counties bordering the Altamaha River is wholly dependent upon the river for transportation, while the remainder is served in part by two railroads—the East Tennessee, Virginia and Georgia, running approximately parallel to the river on its southern side at an average distance of about 15 miles from it, and the Savannah, Florida and Western, crossing the river at Doctortown at about right angles to its general direction. The territory dependent upon the river for the transportation of its produce and supplies is composed of one-third of the counties of Appling, Wayne, Glynn, and all of Tatnall and McIntosh.

An immense business in lumber and naval stores has been developed in the region adjacent to the Altamaha and its two tributaries, and this business is entirely dependent upon these rivers for cheap and remunerative carriage to the ports of Darien and Brunswick. The quantities shipped increase yearly, and those interested in the naval stores business believe that this increase will continue for 14 or 15 years to come;

and then, the activity of the lumber and naval stores business being checked, attention will be devoted to the raising of cotton and grain on the cleared land, and these products will seek a market by the way of the river, which will in all cases offer the cheapest, and, in many instances, the only means of transportation.

The following boats were engaged in traffic on this river during the past fiscal year, viz, the *Swan*, running from Crisp to Brunswick, and the *William M. Wadley*, discharging her freight at Doctortown, whence it is taken by rail to Savannah. These steamers carry annually about 18,000 tons of freight, valued at more than $900,000.

From the Oconee and Ocmulgee Rivers nearly all of the lumber cut has gone through to the coast over the Altamaha. It is believed that 70,000,000 feet, or 169,400 tons, valued at $630,000, is a conservative estimate of this business for the past year. This, added to the steamboat commerce, gives the total tonnage of the river for the past twelve months as 187,400 tons, valued at $1,530,000.

When the Oconee and Ocmulgee Rivers are opened to navigation as far as Milledgeville and Macon, respectively, and a low-water channel 3 feet in depth is secured on all three rivers, the commerce of the Altamaha will undoubtedly be largely increased. It is impossible to give a close estimate of the increase of business that would follow the completion of the works of improvement, but it is possible that it would increase nearly 200 per cent.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1891, $5,982.07. Sapelo Light is the nearest light-house and Forts Oglethorpe and Pulaski are the nearest forts.

Since the present project for improving the Altamaha River was adopted, one appropriation of $15,000 has been made for the work and an unexpended balance of $223.41 transferred from a former appropriation.

The total expenditures under the present project to June 30, 1892, including all outstanding liabilities, were $8,369.11.

It is proposed to expend the funds on hand and any that may become available during the present fiscal year in the removal of obstructions and in the improvement of the shoal places in the river, according to the revised project of 1890.

The sum of $45,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every freshet stage. They should, however, diminish in number from year to year. From $3,000 to $5,000 will be required for the annual maintenance of the completed work.

Money statement.

July 1, 1891, balance unexpended	$13,276.62
June 30, 1892, amount expended during fiscal year	6,135.96
July 1, 1892, balance unexpended	7,140.66
July 1, 1892, outstanding liabilities	286.36
July 1, 1892, balance available	6,854.30
Amount appropriated by act approved July 13, 1892	15,000.00
Amount available for fiscal year ending June 30, 1893	21,854.30

Amount (estimated) required for completion of existing project $99,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894 45,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., February 15, 1892.

CAPTAIN: I have the honor to submit the following report of snagging operations on the Altamaha River, Georgia, for the fiscal year ending June 30, 1892:

The snag boat *Toccoa* continued operations from July 1, 1891, to August 31, 1891, and intended to resume on January 15, 1892, but the high water compelled a suspension of operations, so the boat was taken to Savannah and put out of commission.

Detailed statement of work done to date.

	Snags.*			Stumps.	Overhanging Trees.			Trees girdled.	Logs on bank cut.	Explosives used.	Piles removed.	Rock removed from shoals.	Linear feet of jetty.
	First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.						
1883 to 1891. (Report Chief of Engineers, U. S. A., 1891)	176	741	379	6	910	986	732	5	2	*Lbs* 15	2	*C. yds.* 1,799	1,744.2
1891-'92	38	327	138	18	7	287	717	....	8	....	....	......	......
Total	214	1,068	517	24	917	1,273	1,449	5	10	15	2	1,799	1,744.2

* First-class snags are more than 2 feet in diameter at butt. Second-class snags are more than 8 inches in diameter at butt. Third-class snags are under 8 inches in diameter at butt. All trees and logs under water are considered snags.

Summary of work by months, 1891-'92: Snag boat Toccoa.

Month.	Total days worked.	Days removing obstructions.	Snags. First class.	Snags. Second class.	Snags. Third class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Logs on bank cut.
July, 1891	27	23	24	178	85	15	....	89	273	.....
August, 1891	26	23	14	146	53	3	7	184	423	8
January, 1892	5	1	....	3	....	......	....	14	21	.....
Total	58	47	38	327	138	18	7	287	717	8

Summary of work by localities, 1891-'92: Snag boat Toccoa.

Locality.	Distance above Coupers Bar.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.
		First class.	Second class.	Third class.		Pulled back.	Cut.		
							Over 8 inches.	Under 8 inches.	
	Miles.								
Marrowbone Round	60½	......	2	......	......	......	......	......	......
Oglethorpe Bluff	61	1	11	4	......	......	1	1	......
Lower Sister Bluff	80¼	2	4	1	......	......	......	......	......
Upper Sister Bluff	81½	1	......	......	......	......	2	1	......
Ohoopee River	86	......	......	3	......	......	27	135	......
Tenmile Creek	87½	7	15	3	......	......	8	20	......
Ohoopee White Bluff	89¾	......	9	7	1	......	......	......	......
Iron Mine Reach	91½	7	50	31	10	......	......	......	......
Iron Mine Shoals	94	......	12	2	......	......	28	100	......
Striplings Landings	96	5	23	......	......	......	......	......	......
Mayhaw Bight	97	......	17	9	......	......	14	15	......
Buckhorn Bluff	98	5	45	12	2	......	14	4	......
Sharps Landing	103	3	4	2	......	......	30	105	3
Cobbs Creek	105½	......	2	......	......	......	......	......	......
English Eddy	112	2	57	23	1	......	26	55	......
Baldwins Sign	114	3	39	19	2	......	......	......	......
Barklays Landing	115½	1	9	4	2	......	2	1	......
Bullards Creek	116	......	......	......	......	......	37	97	......
Greys Landing (below)	117	1	15	8	......	......	3	8	5
Halls Ferry	123	......	10	2	......	......	30	60	......
Half Moon Bight	124½	......	......	......	......	7	51	94	......
Town Bluff	127	......	3	......	......	......	14	21	......
Total	......	38	327	130	18	7	287	717	8

No accidents due to snags have been reported. When work is resumed the snag boat should commence at the mouth and work upstream, removing obstructions and cutting overhanging trees.

The boilers of the steamers *Tar Heel* are in the channel at Oswalds Cut (58), and should be removed and placed on the bank. The owners of the steamer *Wadley* have built a new hull, named it the *Altamaha*, and will transfer the machinery from the *Wadley*. They have also purchased the steamer *Americus*, and contemplate running both boats. During a portion of the year the steamer *Swan* has run from Brunswick and Doboy to Crisp, on the Ocmulgee River.

Very respectfully, your obedient servant,

F. C. Armstrong,
Assistant Engineer.

Capt. O. M. Carter,
Corps of Engineers, U. S. A.

N 5.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

The Oconee River rises in the northeastern part of Georgia, flows in a southeasterly direction, and unites with the Ocmulgee to form the Altamaha. A detailed description of this river is given in my report of the preliminary examination and survey, printed as House Ex. Doc., No. 211, Fifty-first Congress, first session. For a special history of past work, see page 1253, Annual Report of the Chief of Engineers for 1889.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 3 to 4 feet, but during the low-water season there are various shoals with low-water depths of not more than 2 feet. The

chief obstructions to navigation consist of sand bars, rock shoals, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of February 5, 1890, provides for the establishment of a navigable steamboat channel 3 feet deep at ordinary summer low water from Milledgeville to the river's mouth.

This is to be accomplished by (1) removing rafts, rock shoals, and sand bars; (2) enlarging portions of the river, revetting caving banks, and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated at $171,000 provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

Between 1812 and 1842 about $45,000 were expended by the State of Georgia in the improvement of this river, and between 1874 and 1875 about $8,575 were expended by the Oconee Steamboat Company between Dublin and the Central Bridge, a distance of 28 miles. Operations under the project adopted in 1878 were begun in 1878, and have been carried on at irregular intervals, as the available funds allowed, ever since. A specific appropriation of $1,500 for improving the section of the river between Skull Shoals and the Georgia Railroad Bridge was expended so as to give a least depth in that reach of 20 inches at extreme low water.

In all there have been removed from the river 5,289 snags, stumps, and logs, 17,795 overhanging trees, and 487 cubic yards of rocks; some small brush jetties have been built, 539 trees have been deadened, and 26 logs cut up on bank. Six hundred (600) cubic yards of stone were quarried and placed in a closing dam at Fishtrap Cut. At Old Boat Yard 19 piles were driven, and 330 linear feet of brush mattresses, 18 feet wide, were sunk in constructing contracting works at that point. A new snag boat was partially built at Abbeville, Ga., under contract with Messrs M. A. Sweeney & Bro.

Up to July 1, 1891, the total expenditures for the work, including all outstanding liabilities, amounted to $52,919.13.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Active operations during the year consisted in the removal of snags, logs, stumps, overhanging trees, and drift material, and in the construction of wattled pile and brush dams at Old Boat Yard.

The snag boat *Ocmulgee* began work November 30, 1891, and continued until January 16, 1892, when operations were suspended owing to high water. There were removed between the mouth of the river and Birds Cut, 26½ miles above, 485 snags and stumps, and 55 overhanging trees. In addition 7 trees were girdled and 23 logs cut up on the bank.

A bank party operated between Milledgeville and Dublin, Ga., a distance of 68 miles, from August 24 to December 20, 1891, and removed from the river and its banks 86 snags and stumps and 16,603 overhanging trees; 109 trees were deadened, 143 logs were cut up on the bank, and 366.5 cords of drift material were cut up. Much of this work was done at Sweeneys Cut, which was filled up with logs, stumps,

trees, two rafts, two lattice bridges, and a bridge trestle. In clearing out this cut, 605.5 pounds of high explosives were used.

The operations of the steam hoister and pile driver at Old Boat Yard were resumed in August, and the work was completed in October. During this period, 146 piles were driven, 935 linear feet of piling were wattled; and 661 linear feet of brush mattresses, 18 feet wide, were sunk and covered with stone. In addition, 13 snags and stumps were removed and the banks at the ends of the dams were protected with brush and stone.

The work of building a new snagboat, the *Satilla*, under contract with Messrs. M. A. Sweeney & Bro., was continued and the boat was completed October 3, 1891.

CONDITION OF WORK JUNE 30, 1892.

The river is in fair condition where work has been done, but still needs much attention, the upper portions especially. The work already done has been of great benefit to navigation, boats now running at stages of water from 2 to 3 feet lower than before the improvements were begun. The spur dams at Old Boat Yard are in good condition and have increased the depth on the shoal so that boats now cross it without difficulty. In 1889 the depth was but 2.6 feet at low water. The dam closing Fish-trap Cut has caused a deepening of the bar that existed in the main channel. A shoal still exists in the wide portion of the river below the cut.

The removal of the overhanging trees above Dublin and the opening of Sweeneys Cut have done much toward placing this portion of the river in a navigable condition. It is still, however, impassable at low water, owing to the numerous snags and logs that obstruct the channel. A year's work by the snagboat and the deepening of several shoals will be necessary to make the navigation of this portion of the river safe and profitable.

COMMERCE AND NAVIGATION.

The Oconee River is navigable from the mouth to Milledgeville, a distance of 147 miles. The boats engaged in the river traffic during the year were the *Lumber City*, running from Little Oakey Bluff, 34 miles from the forks to Ocmulgee station, where the East Tennessee, Virginia and Georgia Railway crosses the Ocmulgee River 12 miles from the forks; and the steamer *Louisa*, running from Dublin (79 miles) to Red Bluff (41 miles), and also making irregular trips up the river from Dublin. The *Lumber City* during a portion of the year ran to Dublin.

List and description of steamers plying on the Oconee River.

Name.	Registered tonnage.	Draft.		Connecting with railroad at—
		Light.	Loaded.	
		Inches.	*Feet.*	
Louisa	220	20	5	Dublin, Ga.
Lumber City	227	22	4	Lumber City, Ga.

These boats carry annually about 20,000 tons of freight, valued at $725,000. The freights consist of iron, spirits of turpentine, cotton, guano, and general merchandise. In addition to the freights carried by the steamers, it is estimated that there are annually drifted down the river 25,000,000 feet or 60,000 tons of timber, valued at $225,000.

The total annual commerce of this river is therefore 80,000 tons, valued at $950,000. Freight rates have been reduced 50 per cent since the work of improving the river began in 1878.

An estimate of the commerce that would probably be developed when the river is in a thoroughly navigable condition from Milledgeville to the mouth is given in Mr. A. S. Cooper's report on the survey of the Oconee River, printed as part of Appendix O 11, Report of the Chief of Engineers for 1890, to which I respectfully refer.

With the further improvement of the river, regular and more frequent trips can be made, and heavier loads carried during low-water stages. A large section of farming and timber land will be opened up, and increased dependence will be placed on the river as a means of transportation for all classes of freight. In the counties bordering the Oconee River the population is about 90,000, the area of cultivated lands about 507,000 acres, and the value of all property from $10,000,000 to $11,000,000. The area tributary to the river is about 1,900 square miles.

In view of the information collected, it is estimated that the commerce on the river after improvement will amount to three times its present value.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1891, $5,982.07. Sapelo Light is the nearest light-house, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving Oconee River was adopted one appropriation of $25,000 has been made for the work and an unexpended balance of $201.18 transferred from a former appropriation.

The total expenditures under the present project to June 30, 1892, including all outstanding liabilities, were $22,403.61.

As outlined in my project of February 5, 1890, it is proposed to expend the available funds and any funds that may become available during the year in the removal of obstruction and in the improvement of the shoals in the river between Milledgeville and the mouth.

The sum of $50,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every high-water season. They should, however, become fewer in number each year. From $1,000 to $5,000 will be required for the annual maintenance of the completed work. The work of removing obstructions has been in the local charge of Mr. F. C. Armstrong, assistant engineer, whose report is appended hereto.

Money statement.

July 1, 1891, balance unexpended	*$17,081.12
June 30, 1892, amount expended during fiscal year	14,283.30
July 1, 1892, balance unexpended	2,797.82
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	27,797.82
Amount (estimated) required for completion of existing project	121,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* Capt. Hoxie deposited 25 cents on December 1, 1888. (See letter from Chief of Engineers, dated November 30, 1891.)

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., February 15, 1892.

CAPTAIN: I have the honor to submit the following report of snagging operations on the Oconee River, Georgia, for the fiscal year ending June 30, 1892:

The snag boat *Ocmulgee* commenced work at the Forks (0) November 30, 1891, and continued operations upstream to Birds Cut (26½), which was reached January 16, 1892. High water compelled a suspension of operations; the boat was taken to Savannah and put out of commission. A bank party was started from Milledgeville (147) on August 24, 1891, and completed its work to Dublin, Ga. (79), on December 20, 1891. Sweeneys Cut (120), around the raft, was opened by high explosives.

Detailed statement of work done to date.

	Explosive used.	Snags.			Stumps.	Driftwood cut up.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Rock removed from shoals.	Rock quarried and deposited in dam.	Log and brush jetties.	Sunken flat removed.
		First class.	Second class.	Third class.			Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.						
	Lbs					*Cords*						*Cu. y*	*Cu. y*	*Cu. y*	
1878-1891 (Report Chief of Engineers U. S. Army, 1891)..	....	1,005	2,881	194 / 844	196	......	1,521	6,794	9,649	540	309	490	600	25	1
1891-'92	612	84	285	156	67	366½	732	5,617	10,316	116	166	....	....	....	....
Total	612	1,089	3,166	1,194	263	366½	2,253	12,411	19,965	656	475	490	600	25	1

Summary of work by months, 1891-'92: Snag boat Ocmulgee.

Month.	Total days worked.	Number of days removing obstructions.	Snags.*			Stumps.	Overhanging trees cut.		Trees girdled.	Logs on bank cut.	Explosive used.
			First class.	Second class.	Third class.		Over 8 inches.	Under 8 inches.			
											Lbs.
November, 1891	5	1	4	4	6	.....	.....	.....	.....	.....	.....
December, 1891	27	20	56	102	93	19	26	10	7	3	.....
January, 1892	17	13	19	94	42	17	14	12	......	20	6½
Total	49	34	79	260	141	36	40	22	7	23	6½

* First-class snags are more than 2 feet in diameter at butt; second-class snags are more than 8 inches in diameter at butt; third-class snags are under 8 inches in diameter at butt. All logs and trees under water are considered snags.

Summary of work by months, 1891-'92: Bank party.

Month.	Total days worked.	Number of days removing obstructions.	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Driftwood cut up.	Explosive used.
			First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.				
1891.												*Cords.*	*Lbs.*
August	9	4	......	......	......	......	36	137	147	6	1	......	......
September	26	26	......	......	......	......	356	2,523	4,081	54	17	......	......
October	27	27	3	20	8	26	......	......	......	......	75	183½	352
November	25	25	2	5	7	5	248	1,121	2,741	33	14	183	253½
December	18	16	......	......	......	......	92	1,796	3,325	16	36	......	......
Total	105	98	5	25	15	81	732	5,577	10,294	109	143	366½	605½

Summary of work by localities, 1891–'92: Snag boat Ocmulgee, and bank party.

cality.	Distance above Forks (0).	Snags. First class.	Snags. Second class.	Snags. Third class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Trees girdled.	Logs on bank cut.	Driftwood cut up.	Explosive used.
	Miles.										*Cords*	*Lbs.*
Forks	0	4	4	6								
Old Boat Yard	1	9	28	21	5							
Devils Elbow	3½	6	23	22	6		6					
	4	1	11	3			13	6	7	2		
	4½	1	5	2								
Tumblebug Island	9½	17	45	24	2		3			1		
Bobs Landing	10	7	16	5	4							
Lapses Cut	11	3	15	6								
Double Lapses	12	12	19	10	2		4	4				
Stave Landing	12½	2	2	4			3	4				6½
Brownings Old Field	13¼		4	4	5							
Brownings Landing	13¾	4	9	13	4							
McArthurs Landing	14½	1	12	2			3					
Burnt Swamp	15½	1	9	3			5					
Clarks Bluff	16	1	5	2	1							
	17½	5	28	7	1			8		1		
Frying Pan Point	18¼	2	11	1						1		
Ocmulgee Cut	18½				6							
Gordon Cut	19	2	12	5			1					
McLeod Lake	22	1	2	1			2			4		
Birds Cut	26½									14		
Keenes Landing	80					1	13	21				
	82					2	146	163		15		
Guytons Bluff	88					2	114	189		3		
Parsons Shoal	96					5	142	205				
Toms Point	103					3	171	247				
Whirligig	106					6	135	215				
Central Railroad bridge	107¾					7	75	340				
	108½					14	110	278	2	1		
	109½					5	119	234	5	3		
	110½					6	123	195		3		
	111½					7	98	157	3	2		
	112½					8	95	225	2			
	113½					10	102	200		1		
	114					5	100	195	2			
	114½					7	128	166		2		
	115					4	125	295	2	6		
	115½					6	101	289	4	1		
	116					11	73	142	1	1		
	116¼					26	48	150				
	116¾					8	32	41				
	117					13	70	175	7			
	117½					15	48	212	1			
	118					13	78	147				
	118¼					8	70	219	3			
	118¾					25	86	161	3	2		
	119					13	68	173	11	6		
	119¼					24	88	206	3		6	
Hickory Bluff	119¾					30	126	238		4		
	120					11	59	170				
Sweeneys Cut	121	5	25	15	31	76	326	774		90	360½	605½
	121½					12	55	122	6			
	122					13	79	183	2			
	122¼					16	73	175	1			
	122½					12	90	157				
	123					15	97	233	3			
	123½					20	144	273	1			
	124					13	123	207				
	124½					22	99	132				
Sweeneys Ferry	125					20	158	230	1			
	125½					20	136	200				
Schinholsters Field	126¼					6	132	179	7			
Whitakers Field	127¼					6	69	110	3			
	128					7	90	157	4			
	129					25	108	117	5			
	130					24	64	101	4	1		
	130½					24	130	161	4			
	131					13	100	169				
	132					11	175	182	1			
	133½					15	154	187	1			
	135					15	135	247	5			
Tucker Ferry	137					16	160	203	6	1		
	140					16	76	46	6			
Camp Creek Bluff	143					5	10	28				
	144					8	26	22				
	146					7	25	51		1		
Total		84	285	156	67	732	5,617	10,316	116	166	366½	612

The dam in Fish Trap Cut (72¾) has answered its purpose, and little water is passing through the cut. I found Sweeneys Cut (121) filled up with logs, stumps, trees, two rafts, two town lattice bridges, and a bridge trestle. This cut was entirely closed; and if work had not been done, another raft would have formed. The river was exceptionally low, and the weather good while the party was at work at the cut. Work was commenced at the lower end of the cut, and everything was cut down to the water. Where obstructions interfered with running drift, saws and high explosives were used. The bridges and a large proportion of driftwood were cut up, hauled out on the bank and burned. Trees were cut back 30 feet from the banks. I believe no further trouble will be had at this point, and that the snag-boat will find plenty of water to pass through, but will have some ten days' work in the cut. All sloughs or sucks should be closed, where possible, and no work should be done with the intention of shortening or straightening the river. Center Cut (38) should be opened, and Jones Old River closed.

The Central Railroad Bridge (107½) has been provided with a drawspan. The Dublin, Wrightsville and Tennille Railroad and the county highway bridges at Dublin (79) are completed and provided with drawspans, as required. The Savannah, Americus and Montgomery Railroad Bridge (130) has progressed as far as masonry piers, but I am informed that one of them is faulty and will delay the work.

When work is resumed, the snag boat should commence at the Forks (0) and continue upstream. For the first 30 miles and above Sweeneys Cut (121) there will be little to do.

The steamer *Lumber City* ran to Dublin a portion of the year, but was withdrawn, and now runs only to the lower end of the river. The steamer *Louisa* continues to connect at Dublin.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 6.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The Ocmulgee River is formed by the junction of the South and Yellow rivers, about 20 miles below Covington, and flows thence in a southeasterly direction about 250 miles, where it unites with the Oconee to form the Altamaha. A detailed description of this river is found in my report of the preliminary examination and survey, printed as House Ex. Doc. No. 215, Fifty-first Congress, first session. For a special history of past work, see page 1258, Annual Report of the Chief of Engineers for 1889.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 3 to 4 feet, but during the low-water season there are various shoals with depths of not more than 2 feet. The chief obstructions to navigation consist of rock shoals, sand bars, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of February 5, 1890, provides for the establishment of a navigable steamboat channel 3 feet deep at ordinary summer low water, from Macon to the river's mouth.

This is to be obtained by: (1) Removing rock shoals and sand bars; (2) closing incipient cut-offs and revetting caving banks; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated at $210,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

Between 1817 and 1837 the State of Georgia expended about $60,000 in the improvement of the river, $10,000 of which were used above Macon. In August, 1877, operations were begun under the project approved by Congress in 1876, and the work has been carried on at intervals, as the funds were available. In all there have been removed from the river 7,891 snags and stumps, 22,512 overhanging trees, 359 cubic yards of rock, and 1,869 cubic yards of earth; 146 logs were cut up on the banks; 850 trees were deadened; 2 jetties were built at Tillman Bar, 2 snag dams at Ashley Landing, and 1 at Indian Timber Landing. Up to July 1, 1891, the total expenditures for the work, including outstanding liabilities, amounted to $92,360.74.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Operations during the year consisted in the removal of snags, logs, and overhanging trees, by the snag boats *Ocmulgee* and *Toccoa*, and by a bank party. The snag boat *Ocmulgee* continued operations on the river until November 24, 1891, when she was transferred to the Oconee River. Most of her work was done above Hawkinsville, between Grocery Creek and Hollimans Ferry, a distance of about 15 miles. The snagboat *Toccoa* worked between the mouth of the river and Fodderstack Cut, a distance of 60 miles, from September 15, 1891, to January 15, 1892, when work was suspended, the funds available having been exhausted. The snag boats removed in all 2,912 snags and stumps and 2,824 overhanging trees; in addition, 35 logs were cut up on the bank.

The bank party continued operations until August 5, 1891, between Cotton Box Cut-off and Hawkinsville, where its work was completed. There were removed 3,932 overhanging trees; 19 trees were deadened, 31 logs cut up on the river bank, the river being partially improved for a distance of 25½ miles.

CONDITION OF WORK JUNE 30, 1892.

The river is in good condition, so far as snags and overhanging trees are concerned, from its mouth to Hawkinsville. The work of the snag boat and the bank party above Hawkinsville during the past year has done much toward placing this portion of the river in a navigable condition, and the steamer *J. C. Stewart* was enabled to reach Macon. Much additional work will be required, however, before the navigation of this portion of the river will be safe and profitable at low stages.

The condition of the spur dams at Tillman Bar remains as described in my last annual report. There is now on this bar a least channel depth exceeding 4 feet at low water where the depth was formerly but 2.6 feet.

COMMERCE AND NAVIGATION.

In the early navigation of this river, about the beginning of the present century, pole boats were used. Afterwards small steamers were added to tow upstream the flats which brought cargoes downstream with the current; and finally, about 1830, larger freight steamers took the place of towboats and flats. Macon was originally the head of

navigation, and through freights were carried from there to the coast. The building of the Central Railroad to Macon in 1845 diminished the traffic on the upper Ocmulgee, and finally the construction of a highway bridge at Hawkinsville made that point the actual head of navigation, and cut off the fertile and finely timbered region between Hawkinsville and Macon from its natural means of communication with the markets. Below Hawkinsville the river traffic continued, but boats were able to run only six or eight months of the year, being stopped at low water by snags, bars, and ledges. Now, however, owing to the works of improvement begun in 1877, boats are rarely stopped at low water, running at a stage 3 feet lower than the former limiting stage, and freight rates have been reduced at least 40 per cent. The operations of the snag boat and bank party above Hawkinsville during the past year, and the alterations of the bridges, have opened the river to Macon; but further improvements are required before navigation of this portion of the river will be safe and profitable.

The following is a list of the steamers plying the Ocmulgee River during the fiscal year of 1891-'92.

Name.	Registered tonnage.	Draft. Light.	Draft. Loaded.	Connecting with railroad at—
		Inches.	*Feet.*	
Harry G. Day	299	16	4	Lumber City.
Lumber City	330	16	4	Do.
Swan	360	18	3½	Abbeville and Brunswick.
J. C. Stewart	235	18	3½	Abbeville.

These boats carry annually about 22,000 tons of freight, valued at $1,123,000. The freight consists mainly of rosin, spirits of turpentine, guano, and general merchandise. In addition to this it is estimated that there are annually rafted over the river 30,000,000 feet, or 56,280 tons of timber, valued at $270,000. The total annual commerce of the river is therefore 78,280 tons, valued at $1,393,000.

A full and carefully prepared statement of the conditions and circumstances that will affect this commerce, when the river is placed in a thoroughly navigable condition from its mouth to the city of Macon, is contained in Mr. J. L. Van Ornum's report on the survey of the Ocmulgee River, accompanying my report of February 5, 1890, and printed as part of Appendix O 12, Report of Chief of Engineers for 1890, to which I respectfully refer. It is impossible to make an accurate estimate of the increased commerce that will follow such improvement. But remembering that new boats are to be added to the Lumber City and Hawkinsville lines; that citizens of Macon await the opening of the river to establish a line of steamers to the coast; that more frequent trips can be made and larger cargoes carried; and that a new region between Hawkinsville and Macon will become tributary to the river, it is not an extravagant estimate to say that the commerce of the river may be increased 100 per cent of its present value.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1891, $5,982.07. Sapelo Light is the nearest light-house, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving the Ocmulgee River was adopted one appropriation of $30,000 has been made for the work, and

an unexpended balance of $244.95 transferred from a former appropriation.

The total expenditure under the existing project to June 30, 1892, amounted to $28,205.77.

As outlined in my project of February 5, 1890, it is proposed to expend any funds now available or that may become available during the present fiscal year in the removal of obstructions and in the improvement of the shoals in the river between Macon and the river's mouth.

The sum of $50,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every high-water season. They should, however, become fewer in number each year. From $1,000 to $5,000 will be required for the annual maintenance of the completed work. The work of removing obstructions has been under the local charge of Mr. F. C. Armstrong, assistant engineer, whose report is appended hereto.

Money statement.

July 1, 1891, balance unexpended	$17,669.06
June 30, 1892, amount expended during fiscal year	15,629.88
July 1, 1892, balance unexpended	2,039.18
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	27,039.18
Amount (estimated) required for completion of existing project	155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., February 15, 1892.

CAPTAIN: I have the honor to submit the following report of snagging operations on the Ocmulgee River, Ga., for the fiscal year ending June 30, 1892:

The snag boat *Ocmulgee* continued operations on the river below Hawkinsville, Ga., until July 14, 1891, when it was transferred to the river above Hawkinsville, and commenced work at Grocery Creek (150½), July 20, 1891. The intervening 17 miles between this point and Hawkinsville were so obstructed with overhanging trees that I decided to commence work at the lowest point reached by the bank party, which was Grocery Creek, the same date. Snag work was continued up stream to a point (164¾) 1 mile below Hollimans Ferry (165¾), and the boat then returned to complete the intervening 17 miles, but was obliged to discontinue work as the river was rising and there was a prospect that the boat would be unable to pass under the Hawkinsville highway bridge, and there were insufficient funds available for an extended stay above it.

The bank party completed the work from Cotton Box Cut-off (158½) to Hawkinsville (133) on August 5, 1891, and was transferred to the Oconee River.

The snag boat *Toccoa* commenced work at the Forks (0), September 15, 1891, and continued upstream to January 15, 1892, when it reached Fodderstack Cut (60), and discontinued work, owing to lack of funds.

I give the following tabulated statements of work done during the fiscal year. The river above Hawkinsville is so deficient in local names, and the work was so continuous, that the record is given principally by river mileage. All distances are above the Forks (0).

Detailed statement of work done to date.

	Snags.* First class.	Snags.* Second class.	Snags.* Third class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Trees girdled.	Logs on bank cut.	Explosives used.	Rock removed from shoals.	Dirt removed from shoals.	Jetties.
										Lbs.	*Cu. yds.*	*Cu. yds.*	
1877-1891 (Report Chief of Engineers, U. S. A., 1891)	994	5,327	1,430	140	2,599	9,530	9,504	855	146	37	359	1,869	2
1891-1892	338	1,624	830	140	556	2,174	4,003	19	66	26½	....	....	....
Total	1,332	6,951	2,260	280	3,155	11,704	13,507	874	212	63½	359	1,869	2

*First-class snags are more than 2 feet in diameter at butt. Second-class snags are more than 8 inches in diameter at butt. Third-class snags are under 8 inches in diameter at butt. All logs and trees under water are considered snags.

Summary of work by months 1891-'92—Snag-boat Ocmulgee.

Month.	Total days worked.	Days removing obstructions.	Snags. First class.	Snags. Second class.	Snags. Third class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Logs on bank cut.	Explosives used.
1891.											*Lbs.*
July	27	21	38	146	52	9	8	27	25	5	......
August	26	20	38	98	74	11	1	4	5	2	......
September	26	24	48	156	138	15	9	24	16	6	......
October	27	27	53	239	151	12	....	34	....	....	2½
November	20	18	33	130	132	24	....	15	....	....	10½
Total	126	110	210	769	547	71	13	104	46	13	13

Summary of work by months, 1891-'92.—Snag boat Toccoa.

Month.	Total days worked.	Days removing obstructions.	Snags. First-class.	Snags. Second-class.	Snags. Third-class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Logs on bank cut.	Explosives used.
1891.											*Lbs.*
September	14	13	11	106	25	1	3	107	113	10	......
October	27	25	45	246	82	17	5	137	295	1	......
November	25	22	23	181	51	19	22	128	294	2	......
December	23	22	25	212	71	25	8	301	689	5	13½
1892.											
January	13	12	14	110	54	7	1	148	397	4	......
Total	102	94	128	855	283	69	39	821	1,788	22	13½

Summary of work by months, 1891-'92.—Bank party.

Month.	Total days worked.	Days removing obstructions.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Trees girdled.	Logs on bank cut.
1891.							
July	27	27	428	995	1,589	19	25
August	5	5	76	254	580	....	6
Total	32	32	504	1,249	2,169	19	31

Summary of work, by localities, 1891-'92.—Snag boats Ocmulgee and Toccoa, and bank party.

Locality.	Distance above forks.	Snags. First-class.	Snags. Second-class.	Snags. Third-class.	Stumps.	Overhanging trees. Pulled back.	Overhanging trees. Cut. Over 8 inches.	Overhanging trees. Cut. Under 8 inches.	Trees girdled.	Logs on bank cut.	Explosives used.
	Miles.										*Lbs.*
Forks	0	......	5	......	....	......	45	29	....	8	.....
Yellow Bluff	1½	......	12	......	....	......	......	......	....	....	.....
Round Bluff	4½	2	6	3	1	......	17	27	....	2	.....
Camp Stave	7	4	56	12	....	1	21	40	....	....	.....
Quinns Shoals	8	8	11	1	....	......	3	......	....	....	.....
Little Ocmulgee River	9½	1	8	3	....	5	......	......	....	....	.....
Geo. Wilcox Landing and above	9½	5	48	13	1	2	67	24	....	....	.....
Hubbard Shoals	13½	8	31	18	2	......	18	22	....	....	.....
Dents Landing and below	14½	4	8	5	3	......	1	......	....	....	.....
Horseshoe Landing	17	4	54	26	6	......	9	5	....	....	.....
Owl Head	19	6	24	10	2	......	50	258	....	....	.....
Slaughter Landing	19½	3	20	5	....	......	......	......	....	....	.....
Winslow Cut	22	......	11	2	....	......	5	......	....	....	.....
Upper Winslow	23	6	32	4	1	......	2	......	....	....	.....
Dodges Old Boom and below	25	5	26	5	2	......	6	3	....	1	.....
Dodges Old Boom and above	25	2	50	10	2	......	8	2	....	1	.....
Horse Creek	27	1	24	9	1	......	......	2	....	....	.....
Mosquito Point	31½	......	7	3	5	......	12	13	....	....	.....
Scuffle Bluff	33½	1	10	......	....	......	......	......	....	....	.....
Rubens Cut	35	5	7	1	5	......	4	28	....	1	.....
Chicken Cut	36½	2	9	3	....	......	11	2	....	....	.....
Flat Tub Lake	37	2	7	2	....	......	......	2	....	....	.....
Bear Lake	38	2	9	5	2	......	3	......	....	....	.....
Rocky Creek	39	3	15	6	1	14	30	87	....	....	.....
Little River	40	2	6	1	1	......	18	18	....	....	.....
Upper Mouth	40½	6	12	3	....	......	......	30	....	....	.....
Coffee Bluff and below	43	7	25	8	2	8	47	110	....	....	.....
Coffee Bluff	43	......	31	5	1	......	14	22	....	2	.....
Barrows Bluff	44½	2	33	13	7	......	15	77	....	1	.....
Stave Landing	46	3	13	5	1	3	37	105	....	....	.....
Lumpkins Lake	46¾	9	60	21	9	5	16	63	....	....	.....
Blackshear Cut	47½	5	16	7	2	......	55	135	....	....	.....
Swains Cut	48	1	10	......	1	......	30	81	....	....	.....
Jacksons Landing	48½	4	20	15	....	......	14	51	....	....	.....
Mark Swains Landing	49½	......	15	4	4	1	21	20	....	....	13½
Jacksonville	50	1	14	1	....	......	90	135	....	2	.....
Georges Cut	51½	1	12	11	4	......	32	155	....	2	.....
Moores Landing	52	1	44	16	1	......	66	88	....	2	.....
Dick Swifts (below)	57½	1	13	3	....	......	......	6	....	....	.....
Dick Swifts	57½	4	4	6	1	......	......	10	....	....	.....
Dormineys Landing	59	2	24	5	1	......	16	28	....	....	.....
Fodderstack Cut	60	5	13	13	....	......	34	110	....	....	.....
Cedar Creek	111½	3	11	2	2	......	3	......	....	....	.....
Bryants Indian Bluff	114	7	13	5	....	......	1	4	....	1	.....
Swift Lake (lower end)	116	3	2	2	1	......	......	......	....	....	.....
Swift Lake (upper end)	117	2	7	3	1	1	4	2	....	1	.....
Wild Boar	118	5	25	9	....	2	12	7	....	1	.....
Ways Landing	120	1	......	3	....	......	......	......	....	....	.....
Seven Sycamore Shoals	127	2	5	1	....	......	2	6	....	1	.....
Buttermilk Shoal	134	......	......	......	....	6	25	78	....	....	.....
	139	7	14	10	10	8	47	124	....	....	.....
	139¼	3	22	16	3	......	......	......	....	....	.....
	139½	5	14	16	3	29	81	125	....	3	.....
	139¾	3	7	4	2	22	74	159	....	3	.....
	141	1	5	5	1	16	36	110	....	....	.....
	141½	......	......	......	....	20	57	67	....	4	.....
	142	......	......	......	....	23	55	90	....	....	.....
	143	......	......	......	....	21	81	113	....	....	.....
Big Indian Creek	144	......	......	......	....	22	37	39	....	1	.....
Nest Egg Bluff	145½	......	......	......	....	10	27	40	....	....	.....
Nest Egg Shoals	147	......	......	......	....	15	42	79	....	....	.....
	147½	......	......	......	....	32	73	176	....	2	.....
	148	......	......	......	....	26	66	126	....	6	.....
	149	......	......	......	....	17	22	60	....	....	.....
Wimberlys Old Ferry	149½	......	......	......	....	7	18	47	3	1	.....
Grocery Creek	150½	3	16	4	1	28	24	87	2	6	.....
Taylors Landing	151	5	15	10	3	33	68	85	3	....	.....
	151¼	2	9	3	....	15	22	24	2	....	.....
	151¾	8	21	12	1	16	34	65	3	3	.....
	152	4	14	11	....	......	......	......	....	....	.....
	152½	8	29	17	1	17	43	53	1	4	.....

Summary of work, by localities, 1891-'92.—Snag boats Ocmulgee and Toccoa, and bank party—Continued.

Locality.	Distance above forks.	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Explosives used.
		First-class.	Second-class.	Third-class.		Pulled back.	Cut.				
							Over 8 inches.	Under 8 inches.			
	Miles.										*Lbs.*
Willis Lake	153	2	3	......	....	10	21	43	....	....	.....
	153½	1	6	2	2	13	41	55	2	....	.....
	154	3	13	8	....	31	62	47	2	....	.....
Westlake	154¾	6	15	22	3	10	34	37	....	....	.....
Graham Lake	155¼	6	24	9	3	11	33	74	....	....	.....
	155½	......	......	......	....	7	30	21	....	....	.....
Falks Landing	156¾	1	......	8	....	15	34	31	....	2	.....
	157	......	10	......	2	......	1	3	....	....	.....
	157¼	1	8	1	....	......	......	......	....	....	.....
	157¾	5	6	3	....	12	42	65	1	....	.....
	158	4	1	4	....	......	4	......	....	....	.....
Cotton Box Cut-off	158½	14	45	82	4	19	39	63	....	1	.....
Beaver Pond (outlet)	159	6	24	18	2	5	6	5	....	....	.....
Flat Creek	159½	9	37	37	....	......	......	......	....	....	.....
	160	7	17	12	4	......	......	2	....	....	.....
	160¼	2	10	10	2	3	4	......	....	2	.....
Dead River	160½	4	14	16	3	......	4	3	....	2	.....
	160¾	9	36	25	....	......	9	......	....	....	.....
Savage Creek	161	3	23	9	1	......	7	......	....	....	.....
	161½	8	36	16	6	......	5	......	....	....	.....
Thompsons Landing	162	3	22	15	....	......	6	......	....	....	.....
	162¼	4	25	10	2	......	......	......	....	....	.....
Adams Park Landing	162¾	3	11	6	....	......	1	......	....	....	.....
	163	......	10	15	2	......	......	......	....	....	.....
	163¼	4	12	4	....	......	......	......	....	....	.....
	163¾	7	20	10	....	......	......	......	....	....	.....
	164	6	19	19	1	......	4	......	....	....	2½
	164¼	11	39	48	5	......	2	......	....	....	.....
	164½	6	23	35	8	......	......	......	....	....	8
	164¾	3	31	20	....	......	2	......	....	....	2½
Total	......	338	1,624	830	140	556	2,174	4,003	19	66	26½

The river from the forks (0) to Fodderstack Cut (60) is in excellent condition, and as regards snags is in good condition as far as Hawkinsville (133). From Hawkinsville (133) to Grocery Creek (150½) little has been done; but from the latter place to a point 1 mile below Hollimans Ferry (165½) the river is in excellent condition. From Hollimans Ferry to Macon (203) nothing has been done. When work is resumed, a snag boat should commence at the Forks (0) and run to Hawkinsville (133) removing the worst obstructions; then complete the work to Grocery Creek (150½), and from below Hollimans Ferry (165½) to Macon (203). This may be done in a year, if the stage of water is favorable to snag work; but it will probably take two years. No rock work has been done for several years, as the snags have been the limiting obstructions, and no plant was available. Most of the snags have been removed. The next appropriation will put the entire river in excellent condition. I believe the time has come when a suitable plant should be provided, and one which is to some extent independent of the stage of water. I believe either a chisel or drilling scow should be built and outfitted, and the opinion of those who have worked them seems to favor the drilling scow.

There is quite a number of shoals in the river, but many of them, with proper care, can be passed at all stages of water. I would suggest working the more important ones first, irrespective of location. The local steamers will do the towage at low rates. Hadems Shoals (92), Davis Shoals (110½), and Seven Sycamore Shoals (126½), are the most important, and should have gaps cut in them and the excavated material deposited in dams. Navigation above Hawkinsville (133) is dependent on the improvement of the shoals, and these should be worked next. Hawkinsville Town Shoal (133½) should have a channel cut next the left bank, the material deposited in the dam, and the dam built up of such loose material as is found in close proximity. Buttermilk Shoal (134) is the most important shoal in the upper river. The present channel is on the left bank, which is the best location. It should be deepened and the training wall and dam built up. If the current is too swift for steamers, there should be facilities for warping. The people of Hawkinsville have been in the habit

of taking stone from the dams for building purposes, and I would suggest that they be notified that it is against the law. Tan Yard Shoals (135) should have a channel cut on left bank and the material deposited in dam and training wall; at lower end of shoal there is a ledge of rock, but the channel on the right bank may be sufficient. Taylors Bluff Shoal (135¼) should have a channel cut on right bank, and the material deposited in a dam. Colliers Bluff Shoal (138) should have channel cut on right bank and material deposited in dam. Nest Egg Shoals (147): One shoal is situated in lower end of Indian Bight, and the other in the middle of the White Bight above. A channel should be cut in both. Wimberly Old Ferry Shoal (149¼) may need some attention, and also a shoal at 157½; but I do not think either will be troublesome.

The highway bridge at Hawkinsville has not been altered, nor has the Covington and Macon Railroad Bridge at Macon. The East Tennessee, Virginia and Georgia Railroad has cleared the channels under the drawspans at Lumber City as directed, but I have not had an opportunity to see if it was properly completed.

The steamers *H. G. Day* and *Lumber City*, connecting at Lumber City, the *J. C. Stewart*, connecting at Abbeville, and the *Swan*, from the coast to Crisp and Abbeville, are the only boats running in 1891–'92. The parties owning the *J. C. Stewart* failed in their stave business and the boat was sold. The new owner ran it to Macon, but under present conditions there could be no profitable business, so the boat was taken to Abbeville.

All sloughs or sucks should be closed, where possible, and no work should be done with the intention of shortening or straightening the river. It will certainly make matters worse. Short bights are very little trouble to steamboats, as it takes little time to work them if too short to steer. Cut-offs will probably have to be made at Tiger Leap (69¾) and above Hollingsworth Ferry (72¾), as it would cost more to close than to open them.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 7.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

About 2 miles above the city of Brunswick, Turtle River is divided by Buzzard Island into two branches, the smaller one, flowing to the eastward of the island and upon which the city of Bruswick is situated, being known as East River, the other retaining the name of Turtle River. These streams unite again about 1½ miles below the city to form Brunswick River. The lower part of East River forms what is known as the harbor of Brunswick. Operations for the improvement of this harbor have been carried on in accordance with a project of improvement prepared by Gen. Gillmore, the officer then in charge, and printed as Appendix M 12, Annual Report of the Chief of Engineers for 1886. This project is an enlargement and modification of a previous one submitted by the same officer and printed as Appendix J 7, Annual Report of the Chief of Engineers for 1880.

For a special report of past work see page 1047, Annual Report Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

Turtle and Brunswick rivers have low-water depths of from 4 to 6 fathoms. Over the shoal in the East River, in front of the city, there was, when the existing project of improvement was adopted, a low-water depth of only 1½ fathoms. The mean rise and fall of tide is about 6.8 feet.

PLAN OF IMPROVEMENT.

The following comprise the main features of the plan of improvement;

(1) A training wall, projecting from the most easterly point of Buzzard Island and located approximately parallel to, and 1,000 feet or less distant from, the opposite shore of East River.

(2) A low dam across Turtle River, extending obliquely upstream from the upper end of Buzzard Island to the opposite shore of Blythe Island.

(3) Short spur jetties in the lower part of East River.

(4) Dredging in the vicinity of Turtle River Dam and on the shoal in the lower part of East River.

The training wall and spurs were to be constructed of palmetto cribs loaded with stone, or of successive courses of log and brush mattresses loaded with riprap stone. The works were intended to establish and maintain a 15-foot low-water channel across the shoal in East River. The cost of the original project was estimated at $73,187.50, and as modified at $190,000.

In 1836 an appropriation of $10,000 was made for the removal of the shoal in East River. Since the adoption of the existing project eight appropriations have been made by Congress for the work, aggregating $162,500.

The project of improvement needs revision.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

A training wall was constructed, springing from a point on the eastern side of Buzzard Island, and extending N. 77° 30′ E. 335 feet; thence S. 14° 30′ 650 feet; thence S. 12° E. 3,549 feet to its present end.

The return work (with the exception of a shore extension 35 feet in length, built of log mattresses) and 780 feet of the main training wall were constructed of palmetto cribs; the rest of the training walls, 3,419 feet in length, of double raft mattresses loaded with riprap stone. Forty-nine cribs were used, 14 of which are in the return work. Each crib is from 20 to 25 feet in length and from 9 to 13 feet in width. The cribs were filled with brush and dredge material capped with stone, and rose from the bottom to the level of mean low water.

The double raft mattresses are from 30 to 40 feet wide, from 3 to 4 feet thick, and are loaded with about 12 inches of stone. In raising to a higher level the work already done, ordinary log and brush mattresses from 15 to 30 feet in width and loaded with from 4 to 8 inches of stone were used.

The old palmetto crib work being too narrow to build upon, foundation courses of mattresses 30 feet wide were laid behind these cribs and close against them. Upon this foundation, courses of mattresses 20 feet in width were laid until the work was raised to the level of the old cribs. The next course then overlapped the old crib work, and upon this new crest mattresses of from 15 to 20 feet in width were laid. Along the return face and at the angle point apron mattresses were laid on the channel side of the work to guard against scour. The return face was brought up to mean high water, and the training wall to 4 feet above mean low water at the angle, gradually sloping down to the level of low water at a point 780 feet beyond.

In 1889 work was resumed, and up to July 1, 1891, the crest had been brought up with brush fascines loaded with riprap stone to about

5.5 feet above mean low water for a distance of 2,290 feet, measured from the return angle of the work. There were used in this work 14,009.72 cubic yards of fascines and 2,726.71 cubic yards of stone.

Dredged cuts from 80 to 100 feet in width and from 14 to 15 feet deep at mean low water were made at various times across the shoal. The material removed consisted of a mixture of sand, loam, and clay, and aggregated 200,394.94 cubic yards.

Up to July 1, 1891, the total expenditures for the work, including outstanding liabilities, amounted to $147,667.61.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Under a contract for dredging awarded May 5, 1891, to Mr. P. Sanford Ross, work was begun on July 29 and continued until December 16, 1891, when the funds were exhausted. A cut about 5,910 feet in length and from 60 to 90 feet in width was dredged through the shoal in East River to an average depth of 15 feet at mean low water. In executing this work, there were removed 49,324.3 cubic yards of material.

CONDITION OF WORK JUNE 30, 1892.

The training wall is in good condition, and the new work is being rapidly covered with a growth of oyster shells similar to those covering the older portions of the work. A slight settlement of the crest of the new work has taken place, due to the compression of the fascines under their load of stone. The work is now compact and solid, and no further settlement is apprehended.

An examination of the channel, made in May, 1892, shows that there are ample depths except at one point, where the 15-foot curves are separated by about 100 feet. Throughout the rest of the channel the average depth is about 16 feet.

COMMERCE AND NAVIGATION.

Previous to the year 1871 the city of Brunswick was of slight commercial importance, the value of the exports for that year being less than $500,000. In 1875 the value of the total exports had increased to $639,000. From that year up to the present, and especially since 1880, the importance of the city of Brunswick has increased with remarkable rapidity.

In 1880 the population of Brunswick was 2,891; it is now estimated at 12,000, and is still growing at the same rate. Taxable property increased in value from $1,300,000 in 1880 to $6,000,000 in 1890. The naval-stores business did not begin here until 1875, but now there is a yearly business of more than $1,000,000. During the same period the lumber business shows an enormous increase. The supply of yellow-pine timber is within easy reach of this port, and is practically inexhaustible. White oak, ash, cypress, hard woods, American mahogany, and live oak are accessible within short distances, and all other classes of hard woods are attainable in unlimited quantities from Alabama, Tennessee, and north Georgia. In 1880 there were shipped from this port 37,000,000 feet of lumber; in 1891 the shipments of lumber amounted to 125,074,000 feet, valued at $1,250,740. Lumber was at one time the chief export of Brunswick, but cotton now holds that place. The exports of this staple during the season of 1884–'85 amounted to but 4,000 bales. Since then the exports of this article have increased

wonderfully, and the present annual shipments amount to about 183,000 bales, valued at $7,355,000.

The following lines of steamers have been established:

Mallory Line, Brunswick to New York, one steamship per week.
Brunswick to Savannah, two steamers per week.
Brunswick to Fernandina, one steamer per day.
Brunswick to Darien, one steamer per day.
Brunswick to river points, seven steamers per week.

The passenger traffic to and from New York over the line now in operation would be greatly stimulated were the outer bar improved so that the steamship company could positively announce the departure of its steamers from Brunswick at the same hour every sailing day irrespective of tides. The inward-bound steamers are often compelled to wait outside the bar for high water, and this circumstance tends to retard the development of the inward passenger traffic.

Besides the lines of steamers previously mentioned, a large fleet of foreign and coastwise steam and sailing vessels is engaged in the Brunswick trade, which consists principally of shipments of cotton, naval stores, and lumber.

Shipments, foreign and coastwise.

Articles.	1890.			1891.		
	Amount.	Value.	Tons.	Amount.	Value.	Tons.
Cotton........bales..	187,446	$8,605,942	46,891	183,382	$7,354,971	44,410
Rosin........barrels..	182,953	365,906	21,619	153,146	306,292	21,440
Turpentine........do...	43,984	791,712	10,150	42,440	509,280	9,780
Lumber........M feet..	191,141	1,914,145	849,648	125,074	1,250,740	300,177
Cross-ties........number..	265,000	106,000	26,500	625,372	250,148	62,537
Miscellaneous........tons..	3,034	75,872	3,034	2,845	71,122	2,845
Total........	....	11,859,577	457,812	....	9,742,553	441,189
Estimated receipts by water, foreign and coastwise........	....	3,937,500	157,600	....	3,014,207	135,000
Total commerce........	....	15,797,077	615,412	....	12,756,760	576,189

Persons interested in the trade of Brunswick estimate that owing to past work of improvement in the harbor freight rates have been reduced from 18 to 20 per cent and that if the improvements were completed according to the existing project the total volume of trade would be increased 200 per cent.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1891, $5,982.07. St. Simon's Light is the nearest light-house and Fort Cinch, Fla., the nearest fort.

Since the work of improvement has begun the following appropriations have been made:

By act of Congress approved—	
March 3, 1879	$20,000
June 14, 1880	10,000
March 3, 1881	5,000
August 2, 1882	25,000
July 5, 1884	10,000
August 5, 1886	22,500
August 11, 1888	35,000
September 19, 1890	35,000
Total	162,500

The total expenditures to June 30, 1892, including all outstanding liabilities, amounted to $161,694.86.

It is proposed to expend any funds that may become available during the present fiscal year in raising the training wall, in dredging, and in making surveys, when, after the necessary data have been obtained, the project of improvement can properly be revised.

The sum $27,500 can be economically and advantageously expended during the coming year.

Money statement.

July 1, 1891, balance unexpended	$14,832.39
June 30, 1892, amount expended during fiscal year	13,950.35
July 1, 1892, balance unexpended	882.04
July 1, 1892, outstanding liabilities	76.90
July 1, 1892, balance available	805.14
Amount appropriated by act approved July 13, 1892	27,500.00
Amount available for fiscal year ending June 30, 1893	28,305.14

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Brunswick, Ga., from January 1, 1878, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1878	116	32,584	850	36	10,218	270	41	19,008	493	193	61,810	1,613
1879	148	44,397	1,000	33	8,235	232	40	17,589	468	221	70,221	1,790
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088
1882	335	123,149	2,659	7	2,095	57	63	26,958	694	405	152,202	3,416
1883	299	110,302	2,[illegible]68	11	4,814	107	87	40,765	979	397	155,881	3,454
1884	239	88,063	1,893	10	4,434	88	126	62,818	1,435	375	155,315	3,416
1885	242	93,280	1,928	10	3,216	97	94	43,284	1,037	346	139,780	3,052
1886	229	88,244	1,751	7	3,262	48	98	47,798	1,164	334	139,304	2,835
1887	194	86,731	1,625	8	3,251	116	102	54,537	1,232	304	144,519	2,973
1888	821	290,500	8,619	9	2,991	76	147	80,330	1,729	977	373,911	10,424
1889	220	92,831	1,764	20	10,035	176	191	113,757	2,403	431	216,623	4,343
1890	316	196,701	3,844	23	7,513	186	126	71,158	1,559	465	275,372	5,589
1891	374	235,565	4,462	20	8,025	164	107	70,228	1,523	501	313,818	6,149

CLEARED.

Year.	Coastwise No.	Coastwise Tons.	Coastwise Crew.	American No.	American Tons.	American Crew.	Foreign No.	Foreign Tons.	Foreign Crew.	Total No.	Total Tons.	Total Crew.
1878	124	32,767	874	28	9,231	236	49	21,218	550	201	63,216	1,660
1879	157	42,345	1,116	21	7,172	172	47	21,730	555	225	71,247	1,843
1880	270	78,913	2,010	14	5,010	115	48	19,970	550	332	103,900	2,675
1881	252	82,155	1,732	17	7,218	156	87	42,659	1,014	356	132,032	1,902
1882	278	96,170	2,086	19	7,761	170	101	48,699	1,139	398	152,630	3,395
1883	257	91,036	1,962	28	11,268	240	124	55,717	1,369	411	158,021	3,571
1884	176	62,927	1,322	38	16,209	335	148	70,612	1,633	362	149,478	3,290
1885	196	71,345	1,481	21	8,696	190	135	62,437	1,456	352	142,478	3,127
1886	184	67,020	1,413	17	7,528	159	117	56,280	1,305	318	130,828	2,877
1887	130	51,305	958	5	5,858	143	131	72,894	1,526	276	130,057	2,627
1888	785	266,152	8,240	13	4,715	116	173	102,360	2,236	971	373,227	10,592
1889	169	65,809	1,273	11	4,266	103	221	130,919	2,830	401	200,994	4,206
1890	247	122,820	2,024	18	8,745	165	172	107,197	2,261	437	238,762	4,450
1891	313	186,171	3,432	26	16,045	234	141	94,827	1,980	480	297,043	5,646

Arrivals and clearances of vessels and commerce at Brunswick, Ga., etc.—Continued.

COMMERCE.

Year.	Value of exports.	Value of imports.	Total collection.
1878	$1,372,842	$400	$4,500.97
1879	1,394,401	3,197	5,644.33
1880	1,702,570	8,098	17,723.27
1881	2,230,000	4,377	29,305.30
1882	2,700,000	2,734	20,058.90
1883	3,437,000	3,093	24,911.61
1884	3,500,000	958	19,780.32
1885	3,063,960	4,008	3,939.27
1886	2,828,656	2,397	5,834.43
1887	4,121,600	*2,815,760	37,520.00
1888	7,552,025	*3,140,231	7,438.04
1889	7,894,281	6,557	8,933.66
1890	7,355,841	7,326	5,748.00
1891	*9,742,553	*3,014,207	5,982.07

*Coastwise and foreign.

Comparative statement of receipts and shipments of naval stores.

Years.	Receipts (barrels).						Shipments (barrels).							
	Stock on hand.		Receipts for year.		Total.		Coastwise and interior towns.		Foreign.		Stock on hand.		Total.	
	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.
1880	3,000	600	36,495	8,661	39,495	9,261	29,339	8,371	7,201	650	2,935	240	39,475	9,261
1881	2,935	240	67,562	13,490	70,297	13,730	37,029	8,621	18,077	3,009	15,191	2,100	70,297	13,730
1882	15,191	2,100	104,357	23,459	119,548	25,559	46,785	11,533	52,972	11,826	19,791	2,200	119,548	25,598
1883	19,791	2,200	80,078	16,105	99,769	18,305	9,846	5,183	74,687	12,229	15,236	1,893	99,769	18,305
1884	15,236	893	105,622	23,449	120,858	24,342	22,859	2,565	98,983	20,167	8,016	2,610	120,958	24,342
1885	8,016	1,610	92,958	30,900	100,974	22,510	20,197	3,556	68,814	26,169	11,963	2,785	100,974	22,510
1886	11,963	2,736	139,366	34,625	151,329	37,410	30,898	15,620	75,094	10,629	45,337	1,161	151,129	37,410
1887	45,337	1,161	125,546	32,338	170,883	33,459	22,356	7,959	111,731	23,986	36,813	1,403	170,890	33,439
1888	27,098	2,420	140,820	37,643	167,918	40,063	29,746	8,339	120,159	27,901	18,013	3,823	167,918	40,063
1889	......	.....	186,000	45,000	......	......	17,753	6,889	152,394	29,560	31,869	2,259	202,016	38,708
1890	31,869	2,259	212,374	42,813	244,243	45,072	37,553	11,772	145,406	32,212	29,421	1,088	212,374	45,072
1891	29,421	1,088	161,402	42,697	190,823	43,875	25,391	5,640	127,755	36,800	30,294	651	183,440	43,091

JOHN H. DEVEAUX,
Collector of Customs.

Capt. O. M. CARTER,
Corps of Engineers.

N 8.

IMPROVEMENT OF JEKYL CREEK, GEORGIA.

Jekyl Creek forms part of the inside passage between Savannah River, Georgia, and St. Johns River, Florida. It connects St. Simon Sound and Brunswick River at the north with Jekyl and St. Andrew Sounds at the south. The creek is about 5 miles in length, is separated from the Atlantic Ocean by Jekyl Island, and debouches into Brunswick River about 6 miles from the town of Brunswick, Ga.

Operations for the improvement of this creek have been carried on in accordance with a project of improvement prepared by General Gill-

more, the officer then in charge, and printed as Appendix N 10, Annual Report of the Chief of Engineers for 1888.

ORIGINAL CONDITION.

With the exception of two points the creek has ample widths and depths to accommodate the largest class of vessels that take the inside route. About a mile from its northern end a shoal is found between the points where Lathram and Mud rivers enter the creek, and from the mouth of the creek to the deep waters of Brunswick River, in the bight formed by the southern shore of the latter, there is an extensive mud flat. The least mean low-water depth across at the mouth of the creek was 3.7 feet. Across the shoal between Lathram and Mud rivers it was 3 feet. The mean rise and fall of the tide is 7.1 feet.

PLAN OF IMPROVEMENT.

The following comprise the main features of the plan of improvement:

(1) A training wall at the mouth of the creek, designed to guide and concentrate the ebb currents across the mud flats to the deep waters of Brunswick River.

(2) Closing Mud River by means of a dam at some suitable point, to prevent the escape of water through that branch at ebb tide.

(3) Dredging through the mud flats at the mouth of Jekyl Creek and in the creek proper, near the mouth of the river.

The training wall and closing dam were to be constructed of log and brush mattresses, or brush fascines, and riprap stone below the level of low water; above that point stone alone was to be used. It was proposed to give the dredged channels a bottom width of 50 feet. The works were intended to establish and maintain a 7-foot low-water channel through the shoals. The cost of the project was estimated at $38,590. In the river and harbor act of August 11, 1888, the sum of $5,000 was appropriated for this improvement. This was the first appropriation ever made for the work. By the act of September 19, 1890, the sum of $7,500 was appropriated, making a total of $12,500.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

Dredging was begun on February 4, 1889, and terminated, on account of the exhaustion of funds, on March 19, 1889. During this period there were removed a total of 20,486.84 cubic yards, 12,546.33 cubic yards of which were removed from the bar outside the mouth of the creek. Jetty work was begun on May 13, and suspended on June 8, 1891, and consisted in laying a foundation course of the training wall 40 feet in width and 513.5 feet in length. There were used in the work 2,282.22 square yards of mattresses, 336.18 cubic yards of stone, and 28.17 cubic yards of brush fascines.

Up to July 1, 1891, the total expenditures for the work, including outstanding liabilities, amounted to $8,888.22.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Under a contract for dredging awarded on May 5, 1891, to Mr. P. Sanford Ross, work was begun December 20, 1891, and continued until January 15, 1892, when the funds available were exhausted. A cut 1,923 feet long and 30 feet wide was dredged through the shoal outside

of the mouth of the creek to an average depth of 7 feet at mean low water. In executing this work there were removed 13,000 cubic yards of material.

CONDITION OF WORK JUNE 30, 1892.

The portion of the training wall constructed in May and June, 1891, is in good condition, and shows no change since its completion.

The dredged cut through the outer shoal shows some shoaling since work was suspended. While the average depth throughout the cut is from 5.5 to 6 feet, there is one point where the 5-foot curves are separated by a depth of but 4.8 feet at mean low water. No dredging was done on the inner shoal, but the channel has maintained its depth fairly well during the year, and there is nowhere a less depth than 5.1 feet at mean low water.

COMMERCE AND NAVIGATION.

The commercial value of the annual traffic through Jekyl Creek is estimated at about $962,000, and the amount of freight carried at about 28,500 tons. It is impossible to secure accurate figures because most of the freight is billed by the package and no records of the weights and values are kept. The above estimate is, however, believed to be a close approximation to the truth. The freights through the channel, outward from the cities of Savannah, Brunswick, and Fernandina, consist mainly of general merchandise and mill supplies. The inward freights are cotton, naval stores, rice, fish, etc.

Tabular statement of commerce on Jekyl Creek.

Route.	Between—	No. of steamers.	Towing.	Trips.	Tons of freight.	Valued at—
Sea Island	Savannah and Fernandina	1	1 barge	Biweekly	26,500	$900,000
Cumberland	Brunswick and Fernandina	1		Daily	600	17,000
Satilla River	Brunswick and Satilla River	2		Triweekly	1,404	45,000
Jekyl Island	Brunswick and Jekyl Island	1		Daily		
Total		5			28,504	962,000

Vessels passing between adjacent ports are often towed through Jekyl Creek, thus avoiding rough weather at sea and the necessity of taking in ballast.

The steamers on the Cumberland route and the Jekyl Island route are passenger boats and carry but little freight. In addition to the boats above mentioned, many small craft carrying rice, farm and garden produce, fish and oysters, pass through this channel.

Owing to the shoal water in Jekyl Creek, the steamers passing through on their regular trips are often delayed several hours while waiting for a suitable stage of tide, and some are reported to have sustained injuries by running aground. The Cumberland route is a part of a through passenger line to Florida via the East Tennessee, Virginia and Georgia Railway, and the delays mentioned interrupt the schedule to the serious detriment of the passenger service.

The completion of the works of improvement will undoubtedly be followed by a large increase in the amount of commerce passing through Jekyl Creek.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1891, $5,982.07. St. Simon is the nearest light-house, and Fort Clinch, Fla., the nearest fort.

The following appropriations have been made for this work:

By act of Congress approved—	
August 11, 1888	$5,000
September 19, 1890	7,500

The total expenditure to June 30, 1892, including all outstanding liabilities, was $12,448.01.

It is proposed to expend the available funds and any funds that may become available during the year in carrying on the improvement according to the approved project. Should the appropriation become small and irregular the cost will be greatly increased. The sum of $18,590 can be economically and advantageously expended during the present fiscal year.

Money statement.

July 1, 1891, balance unexpended	$3,611.78
June 30, 1892, amount expended during fiscal year	3,559.79
July 1, 1892, balance unexpended	51.99
Amount appropriated by act approved July 13, 1892	7,500.00
Amount available for fiscal year ending June 30, 1893	7,551.99
Amount (estimated) required for completion of existing project	18,590.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	18,590.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

N 9.

IMPROVEMENT OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

The entrance to Cumberland Sound is situated between Cumberland Island, Georgia, and Amelia Island, Florida.

Operations for improving the channel across the bar at this entrance have hitherto been carried on in accordance with a project of improvement submitted to the Chief of Engineers by Gen. Gillmore, the officer then in charge, dated June 30, 1879. A discussion of the general question of the application of jetties to this entrance is published as Appendix H 6, Annual Report of the Chief of Engineers for 1878.

For a detailed history of the past work, see page 1054, Annual Report of the Chief of Engineers for 1888.

ORIGINAL CONDITION.

The available depth of the entrance in its unimproved condition varied from 11 to 12.5 feet at mean low water. The mean rise and fall of tide is 5.9 feet.

PLAN OF IMPROVEMENT.

The plan of improvement, as originally submitted by Gen. Gilmore in 1879 and revised by the Board of Engineers in March, 1891, provides for the construction of two low jetties, composed of riprap stone,

with a mattress hearting whenever admissible, resting upon a foundation mattress of brush or logs and brush, starting, respectively, from the shores on opposite sides of the entrance and extending seaward across the bar upon lines so directed that the ends will be parallel to each other and about 3,900 feet apart. These jetties are intended to establish a low-water channel across the bar not less than 19 feet in depth. The cost of the improvement was originally estimated at $2,071,023, and, as modified, at $1,606,500 for the completion of the low jetties and at $2,079,500 if high jetties are found necessary.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1891.

Nothing was ever expended in improving the entrance to Cumberland Sound previous to the adoption of the existing project. Since then appropriations have been made by Congress for the work, aggregating $592,500.

North jetty.—The shore end of this jetty is located on Cumberland Island, about 7,700 feet north 26° 30′ west from the eastern bastion of Fort Clinch. From this point it extends south 61° 30′ east 2,200 feet, thence south 80° east 5,172 feet to its present seaward end.

Work on this jetty was commenced in June, 1881, and suspended in March, 1883. In addition to the foundation course, 7,372 feet in length, a second course extends from the angle point shoreward a distance of 1,439 feet. Foundation courses of two spurs, each 54 feet in length, are also laid on the harbor side of the jetty at distances of 1,627 and 1,800 feet, respectively, from its shore end.

The mattresses of the foundation course of the jetty vary in width from 25 to 52 feet and those of the second course from 20 to 25 feet. The spurs are 42 feet wide.

The mattresses are from 19 to 22 inches in thickness and are loaded with riprap stone to an average depth of 12 inches.

There have been used in the work 46,480 square yards of mattresses and 15,612 cubic yards of riprap stone.

Operations on this jetty were resumed on June 23, 1891, and up to the end of that fiscal year the foundation course was extended 267.4 feet by brush mattresses 100 feet wide loaded with stone. There were used in this work 2,769.35 square yards of brush mattresses and 382.38 cubic yards of stone.

South jetty.—The shore end of this jetty is located on Amelia Island, about 5,800 feet east 18° south from the eastern bastion of Fort Clinch. From this point it extends seaward a distance of 10,062.48 feet, measured along the axis of the work. From the initial point it runs as follows, viz:

	Feet.
Range 1, east	2,041.63
Range 2, north 68° 32′ east	5,625.37
Range 3, north 69° 32′ east	400.00
Range 4, north 71° 32′ east	400.00
Range 5, north 78° 32′ east	400.00
Range 6, north 78° 32′ east	400.00
Range 7, north 80° 2′ east	400.00
Range 8, north 81° east	395.48

In addition to the foundation course a second course 3,967.9 feet in length extends seaward along the second range, beginning at a point 917.7 feet from the intersection of the first and second ranges.

The mattresses of the foundation course vary in width on the first range from 40 to 50 feet and on the second range from 50 to 100 feet.

On all other ranges their width is 100 feet, as is also that of the mattresses of the second course. The mattresses average about 18 inches in thickness and are loaded with riprap stone to an average depth of 12 inches. This jetty has been brought up to the level of mean low water for a distance of nearly 3,123 feet from its shore end, and with a crest width of 16 feet shoreward of the angle and of 22 feet seaward of that point. The structure consists of riprap stone upon the mattress foundation. A hearting of oyster shells was tried, but, being found to be disadvantageous and not economical, was discontinued. The stone has stood well, the slopes assumed on both sides of the jetty being about 1 on 1¼. No breaking down of the work at any point has been observed. There have been used in the work 145,197.86 square yards of mattresses, 74,010.47 cubic yards of riprap stone, and 2,071.80 yards of oyster shells. Up to July 1, 1891, the total expenditures on both jetties, including outstanding liabilities, amounted to $488,347.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Operations on the north jetty were continued under contract with Mr. John F. Gaynor, awarded on May 4, 1891, and were suspended on November 14, 1891, the funds available being exhausted. The foundation course, composed of brush mattresses 100 feet in width and loaded with riprap stone, was extended from a point 7,540 feet from the shore end of the jetty to a point 13,717.9 feet from the shore end, except for a space of 1,031.4 feet, between the 8,762.7 and 9,794.1-foot points, where a gap was left across a shoal that rises above mean low-water level. The inner end of the outer or seaward range of the jetty was reached at a point 12,729.7 feet from the shore end. This range is about north 81° 31′ east. All distances are measured along the axis of the jetty. In the work during the fiscal year just closed, there were used 58,759.61 square yards of brush mattresses and 11,429.93 cubic yards of stone, making a net advance of 5,146.5 feet in the foundation course. This work was carried on in the breakers, where operations are always dangerous and often impossible.

CONDITION OF WORK JUNE 30, 1892.

An examination of the work and of the bar channel was made in May, 1892. The south jetty remains as described in my last annual report. It has received no injury during the year, and is in good condition. The old portion of the north jetty remains as noted in former reports. The new work is in good condition, but is not yet sufficiently extended to have any beneficial effect on the bar channel.

The channel has moved to the south during the year and now crosses the outer end of the south jetty, where the foundation course only has been laid, extending thence almost due east to sea. The available depth is now slightly more than 13 feet, and the inner and outer 15-foot curves are separated by only about 400 feet.

COMMERCE AND NAVIGATION.

All the commerce of St. Mary, Ga., and 90 per cent of the commerce of Fernandina, Fla., are dependent on water transportation through Cumberland Sound.

The Florida Central and Peninsular Railroad, terminating at Fernandina, besides traversing a fertile and well-timbered country, pierces also the Florida phosphate fields, and much of the rock from the phosphate mines is brought by this road to Fernandina for shipment to coastwise and foreign ports. For the handling of this increased traffic, the railroad has built new wharves, erected a large elevator, and ex-

tended its terminal facilities. From information derived from the owners of the principal mines it is estimated that the annual shipments of rock will aggregate about 300,000 tons.

The Mallory line has two steamships per week plying between Fernandina and New York, which carry annually about 61,000 tons of freight. Fifteen steamers per week ply between Fernandina and local coastwise ports, and a large fleet of foreign and coastwise vessels is engaged in the commerce of this port.

In 1891, the shipments, foreign and coastwise, amounted to 205,440 tons, valued at $2,486,527, and the receipts by water were 54,900 tons, valued at $3,938,000.

It is estimated that during the year 1892 the shipment of phosphate rock will be double that of 1891. During the first five months of 1892, from January 1 to June 1, there were shipped 52,188 tons, while the shipment during the entire year in 1891 amounted to 52,428 tons.

Port of Fernandina, Fla.—Shipments and receipts, 1891.

Articles.	Quantity.	Tons.	Value.
SHIPMENTS.			
Foreign:			
Lumber ... feet ..	9,940,975	20,667	$149,115
Phosphate rock ... tons ..	...	52,428	629,136
Coastwise:			
Lumber ... feet ..	57,436,589	119,458	854,549
Cotton (see island) ... bales ..	8,527	2,132	426,350
Rosin ... barrels ..	23,206	3,481	46,412
Spirits of turpentine ... do ...	4,421	774	66,315
Cedar, shingles, rails, and miscellaneous ... tons ..	...	6,500	314,650
Total ...	...	205,440	2,486,527
RECEIPTS.			
Steel rails ... tons ..	...	7,300	219,000
Guano ... do ...	...	43,000	1,419,000
Miscellaneous ... do ...	...	4,600	2,300,000
Total ...	...	54,900	3,938,000
Aggregate ...	...	260,340	6,424,527

MISCELLANEOUS.

This work is located in two collection districts, the north jetty being in the district of St. Mary, Ga., and the south jetty in that of Fernandina, Fla. Fernandina, Fla., is the nearest port of entry. Amount of duties collected in 1891, none. Amelia Light is nearest light-house and Fort Clinch, Fla., the nearest fort.

Since the existing project for improving Cumberland Sound was adopted, the following appropriations have been made for this work:

By act of Congress approved—	
June 14, 1880 ...	$30,000
March 3, 1881 ...	100,000
August 2, 1882 ...	50,000
July 5, 1884 ...	75,000
August 5, 1886 ...	112,500
August 11, 1888 ...	112,500
September 19, 1890 ...	112,500
Total ...	592,500

The total expenditures to June 30, 1892, including all outstanding liabilities, were $590,624.08.

It is proposed to expend the funds available and any funds that may become available during the year in expending and raising the north

jetty, the work to be done in accordance with the revised project of March 11, 1891.

The appropriations heretofore made have been entirely inadequate to an economical and advantageous prosecution of the work of improvement. The most satisfactory results can not be obtained with expenditures the next fiscal year of less than $1,000,000.

Money statement.

July 1, 1891, balance unexpended	$108,173.78
June 30, 1892, amount expended during fiscal year	106,050.69
July 1, 1892, balance unexpended	2,123.09
July 1, 1892, outstanding liabilities	247.17
July 1, 1892, balance available	1,875.92
Amount appropriated by act approved July 13, 1892	170,000.00
Amount available for fiscal year ending June 30, 1893	171,875.92
Amount (estimated) required for completion of existing project	1,817,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Fernandina, Fla., from January 1, 1875, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports. American vessels.			Foreign ports. Foreign vessels.			Total.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	212	117,363	4,192	47	10,379	359	12	7,437	135	271	135,179	4,686
1876	210	141,354	4,749	25	4,893	179	28	9,232	249	263	155,479	5,177
1877	150	100,581	3,343	31	3,768	217	40	12,547	404	221	121,896	3,964
1878	183	120,845	3,900	17	3,985	101	22	8,294	215	222	133,124	4,216
1879	205	133,020	4,133	28	10,634	252	10	5,639	126	243	149,293	4,516
1880	270	146,722	4,470	34	22,396	598	22	9,463	240	326	188,581	5,308
1881	273	171,548	4,186	17	11,899	314	24	11,593	271	278	195,040	4,771
1882	239	146,383	3,279	16	9,056	242	15	6,639	151	270	162,078	3,672
1883	183	96,937	2,453	6	1,769	43	14	5,229	137	203	103,935	2,633
1884	176	105,061	2,864	3	865	21	10	4,029	88	189	109,755	2,973
1885	169	111,698	3,131	7	999	47	22	9,785	210	198	122,482	3,388
1886	205	147,418	4,014	7	2,112	53	15	5,187	146	227	154,717	4,213
1887	349	317,798	5,030	19	6,402	122	22	8,565	220	390	332,965	5,372
1888	274	179,130	4,456	19	7,152	156	18	6,789	177	311	193,071	4,789
1889	262	164,229	3,908	48	16,434	369	39	12,936	363	349	193,594	4,640
1890	267	172,202	3,948	40	14,683	305	33	11,518	306	340	198,403	4,559
1891	226	164,588	3,530	18	6,175	140	34	17,654	433	278	188,417	4,103

CLEARED.

Year.	Coastwise. No.	Coastwise. Tons.	Coastwise. Crew.	American vessels. No.	American vessels. Tons.	American vessels. Crew.	Foreign vessels. No.	Foreign vessels. Tons.	Foreign vessels. Crew.	Total. No.	Total. Tons.	Total. Crew.
1875	229	121,028	4,303	31	8,239	228	15	5,343	212	275	134,610	4,743
1876	244	161,154	5,058	21	6,040	147	26	9,002	269	291	166,196	5,474
1877	165	106,615	3,590	24	6,340	166	42	13,741	412	231	126,596	4,168
1878	195	124,883	4,086	19	4,911	123	26	9,080	236	240	138,874	4,445
1879	175	129,654	4,079	31	11,067	258	12	8,016	164	218	148,737	4,501
1880	244	155,659	4,505	31	14,207	327	24	10,202	240	299	180,068	5,072
1881	204	138,593	3,730	41	22,007	506	31	15,335	351	276	175,940	4,587
1882	217	136,666	3,166	39	15,497	370	31	14,962	321	287	167,125	3,857
1883	153	85,815	2,245	32	8,925	210	24	9,413	231	209	94,153	2,681
1884	178	104,462	2,688	27	8,831	176	15	6,488	158	210	119,781	3,022
1885	185	112,936	2,970	33	10,251	249	21	9,393	221	239	132,580	3,440
1886	214	153,092	4,208	27	9,072	200	26	9,817	299	267	171,981	4,707
1887	306	326,342	4,500	29	8,552	232	33	11,607	327	368	346,501	5,054
1888	280	175,490	4,586	28	9,190	184	20	8,622	204	328	193,302	4,974
1889	298	181,075	4,240	46	13,652	342	45	16,286	428	389	211,013	5,010
1890	276	176,330	4,074	41	14,394	317	34	13,149	319	351	203,878	4,700
1891	228	156,272	3,507	18	6,407	136	49	31,117	702	295	193,796	4,345

Arrivals and clearances of vessels, and commerce, at Fernandina, Fla., etc.—Continued.

COMMERCE.

Year.	Value of exports.		Value of imports.		Total commerce.	Duties collected.
	Foreign.	Coastwise.	Foreign.	Coastwise.		
1875	$209, 791	$1, 119, 979	$14, 304	$755, 718	$2, 089, 792	$1, 817. 84
1876	226, 076	1, 170, 240	46, 179	1, 131, 032	2, 573, 827	2, 181. 40
1877	310, 225	676, 855	19, 304	1, 146, 363	2, 152, 747	2, 376. 00
1878	248, 000	780, 607	8, 142	172, 234	1, 901, 983	2, 090. 00
1879	275, 470	921, 368	11, 038	1, 360, 432	2, 568, 308	3, 424. 00
1880	257, 780	667, 092	3, 676	1, 365, 857	2, 294, 405	7, 808. 00
1881	242, 100	1, 064, 394	11, 791	1, 786, 546	3, 104, 831	8, 183. 00
1882	292, 400	1, 342, 421	45, 792	7, 536, 588	3, 217, 201	36, 590. 00
1883	248, 600	2, 573, 010	11, 229	2, 262, 755	5, 095, 594	5, 566. 00
1884	173, 600	1, 164, 462	1, 874	1, 738, 620	3, 078, 556	1, 331. 00
1885	214, 726	2, 134, 541	4, 180	1, 502, 544	3, 855, 991	1, 451. 28
1886	191, 595	2, 843, 000	590	1, 625, 000	4, 660, 185	808. 00
1887	226, 960	3, 500, 000	23, 896	2, 000, 000	5, 750, 856	3, 400. 00
1888	175, 150	2, 500, 000	....	650, 000	3, 325, 150	4, 655. 06
1889	325, 980	3, 970, 180	601	3, 150, 000	7, 446, 761	4, 712. 49
1890	478, 475	2, 245, 753	10, 902	4, 997, 683	7, 732, 813	7, 335. 82
1891	778, 251	1, 708, 276	....	2, 938, 000	6, 424, 527	None.

JAMES A. PINE,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

Arrivals and clearances of vessels, and commerce, at St. Marys, Ga., from January 1, 1879, to December 31, 1891.

ARRIVED.

Year.	Coastwise.			Foreign ports. American vessels.			Foreign ports. Foreign vessels.			Total.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1879	53	16, 773	378	6	2, 303	54	14	5, 155	143	73	24, 231	475
1880	30	8, 982	202	2	694	17	16	6, 409	185	48	16, 085	404
1881	22	7, 541	156	6	2, 491	54	25	11, 282	290	53	21, 324	500
1882	28	10, 504	196	1	371	7	15	5, 723	146	44	16, 598	347
1883	26	9, 596	132	3	1, 207	24	6	2, 112	44	35	12, 912	250
1884	32	11, 294	224	1	539	9	6	2, 334	57	39	14, 065	290
1885	40	13, 042	280	1	396	8	5	2, 028	52	46	15, 466	340
1886	20	7, 882	140	1	321	7	6	2, 086	56	27	10, 288	203
1887	37	13, 247	222	1	405	9	8	4, 286	90	46	17, 938	321
1888	55	20, 897	440	1	433	8	3	1, 365	32	36	22, 695	489
1889	60	24, 000	540	9	3, 575	70	14	5, 571	133	83	33, 146	743
1890	39	16, 328	300	6	2, 058	45	7	2, 856	68	52	21, 242	413
1891	44	18, 578	322	1	330	8	2	747	20	47	19, 655	350

CLEARED.

1879	53	16, 773	378	10	3, 577	83	14	5, 155	143	77	25, 505	604
1880	30	8, 982	202	3	1, 150	27	12	4, 979	132	45	15, 111	361
1881	22	7, 541	156	7	3, 362	68	29	12, 463	323	58	23, 336	547
1882	28	10, 504	196	4	1, 567	32	18	6, 791	175	50	18, 862	403
1883	26	9, 596	182	3	1, 207	24	6	2, 112	46	35	12, 915	252
1884	32	11, 294	224	2	1, 097	19	6	2, 234	57	40	14, 625	300
1885	40	13, 042	280	3	1, 195	25	4	1, 595	42	47	15, 732	347
1886	20	7, 882	140	5	2, 312	40	5	1, 646	45	30	11, 840	210
1887	......	....	....	1	425	9	8	4, 286	90	8	4, 286	90
1888	56	21, 330	448	5	2, 086	41	5	1, 587	46	66	25, 273	535
1889	60	24, 000	540	9	3, 575	70	14	5, 571	133	83	33, 146	743
1890	......	....	....	3	877	21	7	1, 856	68	10	3, 733	89
1891	1	1	1	5	2, 265	38	2	818	18	7	3, 083	56

Arrivals and clearances of vessels, and commerce, at St. Marys, Ga., etc.—Continued.

COMMERCE.

Year.	Value of exports.	Year.	Value of exports.
1879	$82,491	1886	$36,520
1880	70,411	1887	428,500
1881	149,333	1888	212,045
1882	47,216	1889	343,496
1883	26,902	1890	37,867
1884	22,517	1891	32,300
1885	27,127		

WM. A. WHITE,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 10.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

UNKNOWN WRECK IN SAVANNAH HARBOR.

On November 28, 1891, in dredging a sand lump which had formed in the channel opposite the Savannah, Florida and Western Railway, in Savannah Harbor, the dredge encountered a wreck having over it a depth of 13.4 feet at mean low water. It appeared to be the wreck of a large sailing vessel and could not be removed by the dredge. It lay nearly in the middle of the river, on the edge of the channel, and was a dangerous menace to shipping. Its removal was authorized on December 1, 1891, by the Secretary of War, and the sum of $500, which was, on December 19, 1881, increased to $850, was allotted for that purpose. Proposals for the removal of the wreck were asked for by circular letter. The proposal of Mr. Jacob Paulsen, of Savannah, Ga., bearing date of December 15, 1891, agreeing to remove the wreck for $700, being the lowest, was accepted, and the work was begun on January 21, 1892. One dredge and a force of seven men were employed. All parts of the wreck that could not be removed by the dredge alone were broken up by dynamite, which was exploded on the bottom. The greatest charge exploded at any one time was 60 pounds. In all, 430 pounds of dynamite, 40 per cent nitroglycerine, were used. The work was completed on February 19, 1892, all portions of the wreck, to a depth of 26 feet below mean high water, having been removed.

WRECKS IN DARIEN RIVER AND THREE-MILE CUT, GEORGIA.

On July 14, 1891, the mayor and many citizens of Darien, Ga., presented a petition praying that the wreck of the steam lighter *Molton*, then lying in the main channel of the Darien River, opposite Generals Cut, Georgia, and menacing navigation, be removed. This petition was transmitted to the Chief of Engineers, U. S. Army with the recommendation that $150 be allotted for the purpose of making an examination. This was granted, and the examination was made during the months

of August and September. It being difficult to make a satisfactory detailed examination of the wreck by sounding, the services of a diver were therefore obtained. The wreck was found to be that of a vessel about 150 feet long and from 20 to 25 feet beam. It was deeply embedded in the mud, lay directly in the channel, and had over it a depth of 6.5 feet at mean low water. A number of pieces of round timber had lodged on it. It was so deeply embedded in the mud that it was difficult to determine its exact character; but it was reported to be the remains of the steam-flat *Molton*, sunk during the latter part of the civil war. The position both of the wreck and of the river channel had changed since then, and what could be formerly avoided by a vessel was in July last directly in the river channel and constituted a dangerous obstruction to navigation. It was estimated that this wreck could be removed for $1,100.

An examination was also made of a wreck near the mouth of Three-Mile Cut. This wreck was about 100 feet long and 20 feet beam, and lay diagonally across the mouth of the cut, a part of it being exposed at low water. It was the remains of a steamboat, name unknown, reported as burned and sunk at that point about fifteen years before.

It was estimated that its removal would cost $650, and it was recommended that $1,750 be allotted for the removal of both obstructions, which recommendation was approved by the Secretary of War on September 18, 1891. Formal bids were opened on November 2, 1891, and the contract for doing the work was awarded to Mr. Charles W. Johnston, of Lewes, Delaware, for the sum of $1,490, that being the lowest bid and he being a responsible bidder.

The obstructions were removed by breaking them up with charges of high explosives and then removing the pieces by hand. The outfit employed was—

(1) A small sloop; (2) two small row boats; (3) diving outfit complete; (4) 1,050 pounds of Atlas powder, grade C. The work resulted in the complete destruction and removal of the wrecks. The removal of the wreck of the steamer *St. Matthews* was begun December 3 and completed December 7, 1891. Six hundred and fifty pounds of powder were used and all material was removed and deposited in the marsh. Nothing of any value was found on the wreck. The work of removing the wreck of the steamer *Molton* was begun December 8 and completed December 18, 1891, the wreck being entirely removed. Four hundred pounds of powder were used. Nothing of any value was found on the wreck. All of Mr. Johnston's work was quickly and satisfactorily executed.

Abstract of proposals for removing wrecks in Darien River, Georgia, opened on November 2, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price.
1	Charles C. Ely, Savannah, Ga.	$2,400
2	Enoch Townsend, Somers Point, N. J.	2,345
3	Charles W. Johnston,* Lewes, Del.	1,490

* Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable services.

REMARKS.—Amount available, $1,750.

N 11.

[Printed in House Ex. Doc. No. 62, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF THE INSIDE ROUTE BETWEEN DOBOY AND SOPELO [SAPELO], GEORGIA, WITH A VIEW OF MAKING THE SAME NAVIGABLE FOR SEAGOING VESSELS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 25, 1890.

GENERAL: In compliance with Department letter dated September 20, 1890, I have the honor to submit the following report of a preliminary examination of "the inside route between Doboy and Sapelo, Ga., with a view of making the same navigable for seagoing vessels."

The navigable deep-water route from the Altamaha River to the sea is across Doboy Bar, which has shoaled about 3 feet since 1868, its present maximum mean low-water depth being about 11 feet, which is insufficient for the demands of commerce. Its improvement was not recommended, however, on account of the great cost thereof.

The entrance to Sapelo Sound is one of the best on the South Atlantic coast, and the object of the proposed ship channel between Doboy and Sapelo sounds is to afford an outlet to the sea for the commerce of the Altamaha River.

The present and prospective demands of commerce interested in the proposed route are given by me in a report upon a "preliminary examination from Doboy Island to Doboy Bar, Georgia," made December 6, 1886, and printed as part of Appendix N 16, Annual Report of the Chief of Engineers, 1887. The conditions have not sensibly changed since that report was written.

A project which aims at securing a mean low-water depth of 12 feet between Doboy and Darien has already been approved by Congress, and it assumed that the same depth between Doboy and Sapelo sounds will satisfy all of the requirements of commerce at that locality. To obtain this will require the improvement of Mud River and New Teakettle Creek, or the cutting of a channel from North River to Old or New Teakettle Creek. The proposed route also forms a part of the inside route between Savannah, Ga., and Fernandina, Fla., and to that extent is worthy of improvement. Whether or not the locality is worthy of improvement to the extent contemplated will depend upon the first

cost and the probable cost of maintenance. These can not be determined with any degree of accuracy without a detailed survey and a thorough investigation of the tidal conditions in the locality.

I am of the opinion that such a survey should be made. Its cost will be $1,500.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 28, 1890.

Respectfully submitted to the Chief of Engineers.

In view of the facts and reasons set forth in the report of November 25, 1890, by the local engineer, and from my own personal knowledge, I am of the opinion that the inside route between Doboy and Sapelo, Ga., is worth of improvement so far as it is a part of the inside route between Savannah and Fernandina, but the question of its worthiness of improvement to a greater extent can not be determined without a detailed survey.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

SURVEY OF THE INSIDE ROUTE BETWEEN DOBOY AND SAPELO, GEORGIA, WITH A VIEW OF MAKING THE SAME NAVIGABLE FOR SEAGOING VESSELS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., October 5, 1891.

GENERAL: In accordance with the requirements of section 17 of the river and harbor act of September 19, 1890, and instructions from the Chief of Engineers, dated December 3, 1890, I have the honor to submit herewith my report upon the survey of the "inside route between Doboy and Sapelo, Ga., with a view to making the same navigable for seagoing vessels," together with a project for its improvement and an estimate of the cost of the same.

A brief description of the aim of the proposed improvement and some facts relating to its commercial importance are given in my report upon the preliminary examination dated November 25, 1890, to which I respectfully refer.

The survey of the route was made under my direction in April and May, 1891, by Mr. George W. Brown, assistant engineer. To his report, dated September 5, 1891, which is appended hereto, reference is made for details concerning methods and results.

The navigable ship channel from the Altamaha River to the sea is over Doboy Bar, which has shoaled about 3 feet since 1868, there being at present a mean low-water channel about 11 feet in depth. The mean range of tide is 7.2 feet, but the usual ocean swell on the bar renders the route impracticable at mean high tide for vessels drawing more than 17 feet. This is insufficient for the accommodation of any except

coasting and the smaller class of foreign vessels. Deep-draft vessels load at St. Simon or Sapelo Sound, to which points the lumber from the Altamaha River is towed or drifted. The object of the desired improvement is to allow all vessels to load at Doboy or Darien, which would avoid the expense at present incurred in towing to Sapelo or St. Simon. A project which aims at securing a mean low-water depth of 12 feet between Darien and Doboy has already been approved by the Secretary of War, and Congress, by act of September 19, 1890, appropriated $25,000 for inaugurating the work of improvement.

The entrance to Sapelo Sound is one of the best on the South Atlantic Coast, there being a depth in the navigable bar channel of about 18 feet at mean low water. Sapelo Sound is connected with Doboy Sound through Mud River and Old and New Teakettle Creeks, the usual route being through Mud River and the New Creek.

The opening of a channel 12 feet deep at mean low water between Doboy Sound and Sapelo Sound would, with the completion of the project for improving Darien Harbor, make such a channel continuous between Darien and the sea.

The mean tidal range, as approximately determined by the limited number of observations taken during the survey, is 7.51 feet in Mud River and Teakettle Creek, and 7.62 feet in Front River. This, with a depth of 12 feet at mean low water, would make the channel available for vessels drawing from 18.5 to 19 feet, which draft is ample for the present and prospective commerce of Doboy and Darien.

A study of the results obtained by the survey, in connection with the proposed improvement, shows that only two routes are worthy of consideration, viz, through New Teakettle Creek and Mud River, and through New Teakettle Creek and Front River by means of a cut through the narrow marsh separating them.

In New Teakettle Creek there are three shoals on which the depth at low water is less than 12 feet. Starting from its southern end, the first is 1,000 feet long and would require an average cutting of 1.3 feet to reach a uniform depth of 12 feet. The second is 800 feet long, the average depth of cutting required being 1.3 feet. The third is 800 feet long and requires an average deepening of 1.7 feet. For a channel 250 feet wide the volume of dredging required in New Teakettle Creek would amount to about 21,000 cubic yards. Through Mud River there is but one place where the low water depth exceeds 12 feet, and that is only a few hundred feet in length. At many places a deepening of from 7 to 9 feet would be required, the average deepening over the whole distance being 5 feet. The length of the cut needed in Mud River would be 21,500 feet, and the volume of material requiring to be dredged would amount to 594,000 cubic yards. Mud River is of excessive width and a dredged cut in the soft and yielding material composing its bottom would not maintain its depth without the construction of an extensive system of contracting works to confine and direct the tidal currents through the channel. Such a system would require the construction of 30,000 feet of spur dams and training walls in water averaging about 3 feet in depth at mean low tide. These works should be raised to mid-tide, and should have a broad foundation to insure stability on the yielding material composing the river bottom.

Estimating the cost of dredging at 25 cents per cubic yard in place, of log and brush mattresses at 75 cents per square yard, of brush fascines at $1 per cubic yard, of riprap stone at $3.50 per cubic yard, and of oyster shells at 90 cents per cubic yard, the improvement of this route would cost, in round numbers, $540,000.

The second route proposed, viz, through New Teakettle Creek and Front River, crosses Mud River nearly at right angles to its general direction, then cuts through a strip of marsh 2,400 feet wide into a deep creek between Mud River and Front River, follows this creek 1,000 feet, then cuts through another strip of marsh 1,400 feet wide and reaches Front River, in which are found low-water depths exceeding 12 feet throughout the whole distance to Sapelo Sound, except at one point where a shoal 800 feet long would require deepening by not more than 6 inches.

In New Teakettle Creek the same amount of dredging would be required as for the first route. In crossing Mud River, a cut 2,300 feet long, with an average depth of 9.2 feet, would be required. The total length of the cut across the marsh between Mud River and Front River would be 3,800 feet, with a depth of 19 feet.

To give a channel 250 feet wide at high water would require the removal by dredging of 695,000 cubic yards of material. Mud River should be closed by a dam rising to 3 feet above mean high water and located just east of where it is to be crossed by the proposed new channel. To prevent settlement the dam should have a foundation course of log and brush mattresses 80 feet in width and should be brought up to mean low water by successive courses of fascine mattresses loaded with riprap stone. Above mean low water, stone and oyster shells alone should be used. A small amount of oyster shells may also be advantageously used for loading the mattresses, as a more rapid shell growth would thus doubtless be developed.

Two short spurs between the mouth of the creek and the angle in the closing dam are provided for. A sill course of log and brush mattresses 60 feet wide and loaded with oyster shells and stone should extend entirely across Mud River on the western side of the proposed channel. For 250 feet from the southern shore this dam should be raised to mean high water to train the ebb flow from New Teakettle Creek in the direction of the new channel.

The creek lying between Mud River and Front River should be completely separated from the former by a closing dam rising to 3 feet above mean high water. It may eventually be found necessary to protect some portion of the shore of Front River and to build a short training spur near the entrance of the new cut, but this work is not provided for in the estimates.

An estimate based on the prices assumed for the first route places the cost of the improvement of the second route, in round numbers, at $370,000.

It is possible that a narrow-dredged cut would be enlarged to the requisite dimensions by natural scour, but as there are no deep pockets where the excavated material thus removed would be deposited without injury to the channel this is not recommended.

A third route might be developed by way of Old Teakettle Creek and Front River, but this is not recommended.

ESTIMATES.

New Teakettle Creek and Mud River:	
Dredging 615,000 cubic yards, at 25 cents	$153,750.00
Mattresses, 242,060 square yards, at 75 cents	181,545.00
Stone, 33,100 cubic yards, at $3.50	115,850.00
Oyster shells, 20,000 cubic yards, at 90 cents	18,000.00
Total	469,145.00
Engineering and contingencies, 15 per cent	70,371.75
Aggregate	539,516.75
New Teakettle Creek and Front River:	
Dredging 716,000 cubic yards, at 25 cents	179,000.00
Mattresses, 51,000 square yards, at 75 cents	38,250.00
Fascines, 29,400 cubic yards, at $1	29,400.00
Stone, 18,800 cubic yards, at $3.50	65,800.00
Oyster shells, 10,200 cubic yards, at 90 cents	9,180.00
Total	321,630.00
Engineering and contingencies, 15 per cent	48,244.50
Aggregate	369,874.50

Whether or not the improvement above outlined should be undertaken depends on a comparison between the expenditures involved in executing the work of improvement and the money value that would accrue from the improvement to the commerce of Darien and Doboy. The estimated cost of the improvement is $369,875, which capitalized at 5 per cent would yield an annual interest of $18,494. To this must be added the annual expenditures needed to keep the completed work in repair, to dredge the shoals that may develop or reform, to protect caving banks, etc. It is estimated that for the first ten years an annual expenditure of $5,000 may be required for the above purposes. After that period it is expected that the whole work would be practically self-maintaining.

The commerce of the port of Darien amounts to a little more than $1,000,000 annually, and consists of exports of timber and lumber, together with small quantities of naval stores, cotton, and rice. The timber and lumber shipments amount to about 80,000,000 superficial feet annually. Of this amount, 55,000,000 feet are shipped coastwise, paying about $275,000 for freight, and about 25,000,000 feet are shipped foreign, paying for freight approximately $375,000. The coastwise shipments would not be greatly affected by the proposed improvement, since vessels engaged in that trade are mostly of light draft and are afforded fair accommodations under the present conditions. The saving that would result in freight on foreign shipments may be approximately measured by the cost of towing or drifting lumber to St. Simon or Sapelo, where there are good harbors. This is reported to be about 25 cents per 1,000 feet.

The proposed improvement might perhaps result in increasing the foreign shipments and in slightly reducing the freight on coastwise shipments. Assuming the foreign shipments to be increased to 40,000,000 feet, it is not probable, from the data available, that the saving would be in any case greater than $15,000 per annum, which is less than the interest on the first cost of the improvement, to say nothing of the annual expenditure necessary to maintain the improved channel. It does not, therefore, appear that the benefits to be derived from the construction of a ship channel from Doboy Sound to Sapelo Sound are sufficent to warrant the necessary expenditure, especially as the Altamaha region, which supplies all of the shipments from Darien, is

connected by rail with the ports of Savannah and Brunswick, and the harbor of Darien is connected by the "inside route" with the same ports, both of which are now being improved by the United States.

In view of all of the foregoing, I am of the opinion that the "inside route between Doboy and Sapelo, Ga., with a view to making the same navigable for seagoing vessels," is not worthy of improvement.

APPENDIXES.

1. Report of Mr. George W. Brown, assistant engineer.
2. Map of Mud River: *scale, 1:4,800.

Very respectfully, your obedient servant,

O. M. CARTER,
Capt., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., October 12, 1891.

Respectfully submitted to the Chief of Engineers.

I agree with the local engineer that the existing conditions do not justify the improvement by the United States of the "inside route between Doboy and Sapelo, Ga., with a view to making the same navigable for seagoing vessels," and therefore say that in my opinion it is not "worthy of improvement."

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

REPORT OF MR. GEORGE W. BROWN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., September 5, 1891.

SIR: I have the honor to submit the following report upon a survey of the inside route between Doboy and Sapelo, Ga., made during the month of April, 1891, in accordance with your instructions of March 21, 1891. The instructions given at this and subsequent dates were substantially as follows:

"A survey should be made of the inside route between Doboy and Sapelo, with a view of making the same navigable for sea-going vessels. Under this head a survey of Mud River, from Sapelo Sound to the Teakettle creeks, and of New Teakettle as far down as Marsh Creek, should be made. A survey of Front River should also be made, with reference to connecting it with Mud River by a cut 12 feet deep at mean low water and with a minimum bottom width of 100 feet. Observations should be made to determine the range of tide and the direction and velocity of both bottom and mean tidal currents during both ebb and flood flow."

SURVEY PARTY.

The survey ordered was begun on April 8, and was carried on by the same party and in connection with the survey of the inside route between Savannah, Ga., and Fernandina, Fla. The expense of this survey was, however, paid from the distinct allotment for that purpose. The survey party consisted of 1 assistant engineer, 1 transit man, 1 leadsman, 2 gauge-readers, 3 boatmen, and 1 cook, besides the master and the engineer of the United States snag boat *Tocoa*, which boat was used on the survey for quarters.

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*Not printed.

METHODS.

The field work of the survey was conducted as follows: Soundings were taken from a yawl boat handled by two boatmen. The boat carried the leadsman, the assistant engineer as recorder, and an alternate boatman, who held vertically in the boat a stadia rod. The face of the rod was kept constantly toward the transit man. The soundings were located by means of one transit, each location being given by an angle and the stadia distance. The angles were in degrees and minutes from the magnetic north point, carefully determined at each position of the transit. The transit man signaled with a small flag at each sounding located, giving the first signal on each line run with a red flag, after which white and red flags were used irregularly. The time of beginning and ending each line was recorded, but the times of the separate signals were not taken. Locations were referred to their proper soundings at the end of each day's work by means of the color of their signals as recorded in both transit and sounding books. Less trouble was experienced in checking up at night than is usual when time signals are given. Under ordinary conditions soundings could be located in this way with great accuracy within a radius of 2,000 feet, and under more favorable conditions at a distance of 3,000 to 3,200 feet. An especially devised stadia rod 16 feet long was used, which could be easily and accurately read at long distances. Except on the outer 3 miles of Mud River, where the channel is very wide, long sights were not necessary.

On this survey the locations averaged not more than thirty seconds apart. At times every alternate sounding in 10 or 12 feet of water was located. With the assistance of a flagman much more rapid work could be done. With the flagman to act as boatman much time could be saved in moving the transit man from one station to the next. The advantages of this method of location over that by two transits and time signals are, that many more soundings can be located and less time be expended in moving one transmit man than in moving two. This method, although more especially adapted to comparatively narrow streams, was employed very successfully at this place. The close checking of cross lines and the general directness of the platted path of the boat, whether in sounding or in following floats, shows that the locations were very accurately made. Transit stations were taken on both sides of Mud River and the sounding lines from either side were run halfway across the stream. The stations were referred to each other by means of angles and stadia distances through intermediate turning points. Angles at the turning points were not measured. Each transit point was marked by a distinguishing flag, to which angles were taken from subsequent positions of the transit.

PLATTING.

The instrument used on this survey was a Blunt transit, No. 843. Its full stadia interval was 0.96 foot to 100 feet and its half interval was 0.48 foot to 100 feet. Instead of reducing the stadia distances to feet, a scale was constructed which from the stadia reading gave the correct distance on the scale of the map. (Scale: 1 inch = 400 feet.) Such a graduated scale, in the form of a straightedge swinging at its zero point from a needle marking the proper station, to the graduations of a hollow protractor, enabled us to plat the locations very rapidly and accurately.

TIDE GAUGES AND BENCH MARKS.

A tide gauge was established near the east side of Mud River, about three-quarters of a mile southwest from Sapelo High Point. This was read for one high and one low water each day from March 27 to May 4. A second gauge was established at the mouth of Marsh Creek, about a mile from the junction of New Teakettle Creek with Mud River, and was read for one high and one low water each day from April 14 to April 29. A third gauge was established in Front River, about a mile from Sapelo Sound, but was read only while the survey of that river was in progress. The observations at this gauge, however, cover two good determinations of both high and low water. Bench marks were established as near each gauge and in as permanent a manner as practicable. Gauge No. 1, in Mud River, is referred to two bench marks on trees near the bank on Sapelo Island. The bench near gauge No. 2 is on a gas pipe in the marsh, while the bench for gauge No. 3 is on the corner of the ballast wharf, on the west side of Front River. The map accompanying this report shows the positions of all gauges and bench marks.

ESTABLISHMENT.

The standard gauge for this survey was that in Mud River. It was intended to reduce the means of the observations here for high and low water to mean high and mean low water by comparison with the records of the self-registering gauges at

St. Simon Island and at Fort Pulaski; but it was found, on completion of this survey, that the latter gauge was not running during this time. The mean of the tides observed at this place gave high water at 10.56 feet, and low water at 3.25 feet on this gauge. At St. Simon Island the mean of the same tides gave high water 0.19 foot lower and low water 0.01 foot higher than the elevation of mean high and mean low water at that place. Applying these corrections to the mean of the observations for Mud River gives 10.75 feet for the elevation of mean high water and 3.24 feet for the elevation of mean low water on the Mud River gauge. These results have been adopted as correct.* The mean range of tide for Mud River is 7.51 feet. An attempt was made to reduce the observed tides to mean tides by comparison with those predicted tides for this place as given in the United States Coast Survey tide tables. The mean for Sapelo Sound, of the tides we observed should have been, according to these tables, 0.73 foot higher for high water and 0.25 foot higher for low water in order to equal the normal tides for that place. In the Coast Survey tide tables Sapelo Sound is referred to Fort Pulaski, while places to the south of Sapelo are referred to Fort Clinch. If, however, the tides for Sapelo were referred to Fort Clinch, the mean of the tides we observed should have been, according to the tables, 0.20 foot higher for high water and 0.25 foot lower for low water in order to equal the normal predicted range for Sapelo Sound. It is, of course, possible that for a given month low water should average 3 inches *below* mean low water at Fort Pulaski, and that for same time low water at Fort Clinch should average 3 inches *above* mean low water; but there is no sufficient reason why for this period the tides for Sapelo and points north should average 3 inches *below*, while those for Doboy and points south should average 3 inches *above* mean low water. No attempt was made to correct the observed establishment of high water. The time and heights of high and low water at the gauges in New Teakettle Creek and Front River have been referred to those at the gauge in Mud River. The following table shows the results of the tidal observations at the three gauges:

Gauge.	Latitude.			Longitude.			Establishment high water.		Low-water luni-tidal interval.		Duration of rise.		Duration of fall.		Mean range of tide.
	°	′	″	°	′	″	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*Feet.*
Mud River	31	31	18	81	14	31	7	49	13	48	6	26	5	59	7.51
Front River	31	30	44	81	18	00	8	04	13	59	6	30	5	55	7.62
New Teakettle Creek	31	28	27	81	17	36	8	01	13	59	6	27	5	58	7.51

The following table is taken from the U. S. Coast Survey chart:

Gauge.	Latitude.	Longitude.		Corrected establishment high water.		Low water luni-tidal interval.		Duration of rise.		Duration of fall.		Mean range of tide.
	°	°	′	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*Feet.*
Sapelo Sound	31	81	13	7	27	13	32	6	20	6	05	7.0
Doboy Sound	31	81	20	7	30	13	36	6	19	6	06	7.2

A portion of the difference which exists between my results and those of the U. S. Coast Survey is due to the fact that my establishment for high water is uncorrected to mean epoch. The position of the Coast Survey gauge for Sapelo Sound was about 2 miles nearer the ocean than my Mud River gauge.

MAP.

The map† accompanying this report shows in black the results of this survey. Those portions of the map in red were copied from the current U. S. Coast Survey chart. The soundings in red refer to the plane of mean low water as established by the U. S. Coast Survey; while those in black refer to a plane 0.2 foot above that of mean low water. (The present survey shows the water too deep at all points by 0.2 foot.) Your instructions did not include a survey from the mouth of New Tea-

*The soundings were reduced to 3.44 feet on the Mud River gauge before the correct elevation of low water was determined. The depths of water on the map accompanying this report are all too great by 0.2 foot.

†Not printed.

kettle Creek west; but in order to determine whether it were more practicable to connect Front River with New than with Old Teakettle Creek, I extended the survey about 2 miles farther west in Mud River and down Old Teakettle Creek about 2 miles to deep water from Doboy Sound. Beyond this survey, in both directions, the map has been extended to the sounds by copying from the current Coast Survey chart.

DEPTH OF WATER.

In Mud River, between Sapelo Sound and New Teakettle Creek, less than 12 feet of water are found in the present channel for the whole distance, 24,800 feet. In New Teakettle Creek, for the first mile below its upper end, are three places carrying less than 12 feet, having a total length of about 1,600 feet. The depth in the channel through Mud River is 4.8 feet at the shoalest place, and averages for the whole 24,800 feet about 6.6 feet. For the 1,600 feet of shoal in New Teakettle Creek the least depth is 9.3 feet, while the average is about 10.3 feet. Old Teakettle Creek from Doboy to Mud River carries at least 12 feet of water, except for about half a mile in the wide-spread 1¾ miles below Mud River, where the least depth is 7 feet. On the crossing between the upper end of Old Teakettle and the mouth of Scott Creek less than 12 feet of water are found for the entire distance—about 3,000 feet. At the shoalest place on a direct line on this crossing the water is about 6.1 feet deep. Scott Creek is crooked, too narrow for boats, and carries only from 1 foot to 6 feet at mean low water. In Mud River between the two Teakettles the water is from 6.5 feet to 19 feet deep, while to the west of Old Teakettle it is from 12 to 17 feet deep for the first mile. Front River from Sapelo Sound carries from 13¼ to 30 feet at mean low water for the first mile. Twelve feet of water are found for the next mile, except for about 1,200 feet, which carry from 10 to 11.9 feet. In the third mile 12 feet at mean low water are found only for about one-third the distance. The other two-thirds of a mile carry in one place not more than 3 feet. The upper half mile of Front River affords not to exceed about 3 feet at mean low water, and is too crooked for anything but the smallest boats. In the creek tributary to Mud River on the west there are found for the first mile above its mouth from 7.8 feet to 36 feet of water. The second mile carries from 8 to 12.5 feet. The next three-quarters of a mile carry from 10 to 18 feet. Beyond this the creek shoals up rapidly. From the mouth of this creek outward toward Sapelo from 7 to 17 feet of water are found for the first 1½ miles.

CHARACTER OF RIVER BOTTOM.

The bottom of Mud River from Sapelo Sound to the head of New Teakettle Creek grades from a fine soft mud in the shoalest parts to a sticky mixture of mud and clay in the deeper parts. Hard bottom, composed of sand and mud, is found in a few places, but never in or near the channel. In Mud River, opposite the head of New Teakettle Creek, the shoal, a portion of which is exposed at low water, is composed of layers of fine round sand and blue mud and is quite hard. In New Teakettle Creek the bottom is of mud and clay with some sand. In Old Teakettle Creek the bottom is of clay and mud in the deeper parts. The shoal at the wide-spread in the creek is coarse sand and stiff mud. At the south end of this shoal, opposite the small islands, the bottom is of coarse, light-brown sand. In the upper end of Old Teakettle Creek is an exposed bar of sand, very coarse at the upper end but finer farther south. In the deep channel at the east side of this bar the bottom is composed of gravel, sand, shells, mud, and decomposing vegetable matter. The shoal crossing, on a line with the channel on the east side of Old Teakettle Creek and Scott Creek, or the west end of Mud River, is composed of very fine sand and blue mud. The shoal in the middle of Mud River, just northeast of the upper mouth of Old Teakettle Creek, is composed of sand and mud. On the east end the sand is fine, while on the west it is coarse sand or fine gravel. Farther to the west in Mud River, midway between Old Teakettle Creek and Scott Creek, the bottom is of fine sand and stiff mud. In Scott Creek the bottom is also of sand and mud. The upper end of Front River appears to be of mud and clay, with very little sand except at a small bar of sand and mud about half a mile from Scott Creek. Farther down Front River the bottom is of a fine clay, medium hard and sticky. At a mile from Scott Creek no sand is found except on the bars. The sides and bottom are of mud and clay. At a mile and a half from Sapelo Sound, where Front River takes a wide detour to the east, the bottom and sides are of mud and clay. On the bottom are found a few broken shells. Farther toward the sound the bottom is of stiff mud and clay only. No sand is found here. In the creek between Front River and Mud River, and tributary to the latter stream, is found considerable sand on the shoals below low-water line. The banks of Mud River are pretty well studded with beds of bunch oysters. These oysters are also found in the upper half mile of New Teakettle Creek, pretty much

all through Old Teakettle Creek, in the lower mile of Front River, and near the mouth of the creek to the west of Mud River and tributary to it. All through Mud River the banks are very flat. The banks of Old Teakettle Creek, Scott Creek, and the upper end of Front River have a slope not steeper than 1 on 3; while the banks of New Teakettle Creek and for the lower 2 miles of Front River are very steep. In the deep bight, about 1¼ miles from the mouth of Front River, the banks stand well, as steep as 1 on 1¼ from the top of the banks to 10 feet deep at mean low water.

CHANGES TAKING PLACE.

By comparing the depths of water, as given by the present survey, with those copied from the Coast Survey chart, it will be seen that Mud River between Sapelo Sound and New Teakettle Creek is filling very rapidly, particularly to the east of the channel. The 12-foot curve of the former survey (probably about 1858), which bordered the deep pocket along Sapelo Island, now shows from 7 to 9 feet only. From the tables of comparative depths, given in my report upon the survey of the inside route between Savannah and Fernandina may be gleaned the facts set forth in the following table:

Mud River.	Mean of the depths given on coast survey chart.	Mean of the depths at same positions, survey, 1891.
	Feet.	*Feet.*
In or near channel	6.0	5.9
To the west of channel	5.3	4.8
To the east of channel	6.2	3.8

It will be seen that while the channel is holding its depth the river to the east is very rapidly filling up. Above New Teakettle Creek, Mud River seems to have now about the same water as thirty-five years ago. The shoal opposite the mouth of New Teakettle Creek, in Mud River, has filled up from 1 to 2¼ feet, while that to the northeast of the mouth of Old Teakettle Creek has deepened by about 1 foot. New Teakettle Creek has deepened slightly. The shoal at about half a mile from its north end has deepened about 2 feet. Old Teakettle Creek remains about the same as formerly. The tendency, on the whole, seems to be toward deepening. On the shoalest part of the channel (in the wide-spread), the water remains about the same as thirty-five years ago. Neither shoaling nor deepening seems to have taken place in Front River, particularly in the lower 2 miles. Little or no change appears to be taking place in the position of high-water line within the limits of this survey, except on the east side of Mud River. For the first 2 miles from the sound the sand banks of Sapelo Island seem to be washing slightly, while farther to the south, along the marsh on the same side of the river, the banks seem to be making into the river slowly.

TIDAL CURRENTS (DIRECTIONS).

Accompanying the map of the route between Doboy and Sapelo is a diagram showing the directions and velocities of the currents in Mud River and the Teakettle creeks. The arrows on this diagram show, in a general way, the position of the strongest currents, with their directions and velocities. The mean velocity, in feet per second, for the vertical is shown by the lengths of the arrows in inches. Not all of the velocities, however, were actually measured. The exceptions were estimated by comparison with those measured. The time between one low water and the following high water is divided into six equal parts, or lunar hours, and are numbered from I to VI, and between high water and the following low water, into six equal parts, numbered from VII to XII, XII being the time of low water and VI being the time of high water. To better distinguish the directions at any one time, six colors are used on the diagram. Black shows conditions at low and at high water; green at I and VII lunar hours, carmine at II and VIII hours, yellow at III and IX hours, brown at IV and X hours, and scarlet at V and XI hours. A solid dot of any color shows position of slack water at the corresponding time. The directions and velocities given on this diagram are those which occur under normal range of tide and with little or no wind. A very complicated system of currents is found in Mud River, near the Teakettle creeks. A great deal of time was spent here in bringing the currents into a definite system.

Much of the time we were on this survey the tidal currents were seriously affected by heavy winds. Eliminating the effects of wind, the directions of the currents for a normal range of tide are about as follows: At about an hour before low water the

tide is slack in Mud River at a point about one quarter of a mile to the northeast, and at another about half a mile to the southwest of the mouth of New Teakettle Creek. From both areas of slack water the current draws into and runs toward the south in New Teakettle Creek. Farther to the east the ebb tide runs toward Sapelo, and to the west toward Doboy, through Old Teakettle Creek. At this time a good current is found in Old Teakettle Creek, and in New Teakettle Creek from the mouth of Marsh Creek south. In the upper end of this creek the current is very weak. During the last hour before low water the area of slack water east of New Teakettle gradually moves to the west past the mouth of this creek and joins the slack water area between the two Teakettles. At fifteen minutes before low water the water from 1,000 feet west of New Teakettle runs toward the east, and divides between that creek and Sapelo Sound. At the time of low water the tide is still running toward the south slowly, from an area of slack water in the upper end of New Teakettle Creek. A good current is then flowing in Mud River from a point between the two Teakettles, toward Sapelo. Fifteen minutes after low water the current begins to run to the north through the whole length of New Teakettle Creek, and on reaching Mud River it turns to the northeast toward Sapelo. The flood current flows in that direction for at least 2¼ miles from New Teakettle, when it meets that from Sapelo in an area of slack water. At this time slack water is also found in Mud River, between the two Teakettles.

At one hour after low water a strong current flows to the north through New Teakettle and dividing flows both ways in Mud River. An area of slack water between this current and the flood from Sapelo is then found at least 1¼ miles from New Teakettle. The current toward the west from New Teakettle Creek crowds closely along the south bank of the river until the narrowest part is reached, when it crosses the river and continues to the west close under the north shore. From the narrow part of the river the current to the west is at this time very weak. In Old Teakettle Creek at one hour after low water a good flood current is found, which, on reaching Mud River, turns to the west, and joining that from New Teakettle, goes to fill up the blind end of Mud River. For the next two hours or more, or until a little after half flood, the current from New Teakettle Creek continues to run both toward Sapelo and toward the head of Mud River. During this time the area of slack water to the northeast of New Teakettle gradually moves to the west until about three and one-fourth hours after low water, when it reaches the mouth of New Teakettle Creek and disappears. As the current from this creek toward the east slackens that toward the west increases.

From three and one-half to five and one-half hours after low water the flood tide from Sapelo runs to the west, and, joining that from Doboy through both Teakettles, flows into the blind end of Mud River. At half an hour before high water the flood current in Old Teakettle Creek overcomes that from New Teakettle and Sapelo, and, pressing to the east as far as the mouth of New Teakettle Creek, throws the entire flow from the latter creek toward Sapelo. Shortly after high water a dividing exists in New Teakettle Creek, at the north side of the mouth of Marsh Creek. Ebb from Marsh Creek and farther south flows toward Doboy, while from above Marsh Creek it flows toward Sapelo. Water from the blind end of Mud River divides at Old Teakettle Creek, a portion going toward Doboy through that creek, while the remainder continues on toward Sapelo. During the next two hours the dividings in New Teakettle Creek gradually shift toward Mud River. At two hours after high water the current is slack in the north end of New Teakettle Creek, but immediately afterward it begins to run toward the south. As long as the ebb from the upper end of New Teakettle sets toward the north a very strong current toward Sapelo is found close to the north end of the creek in Mud River. At three hours after high water the current in Mud River, just north of New Teakettle, is nearly slack; but to the northwest, upon the opposite side of the river, the ebb continues to flow toward Sapelo for an hour longer. At this time (half ebb) New Teakettle carries to the south the greatest part of the flow from the head of Mud River, which is not diverted into Old Teakettle. At four hours after high water, slack water exists all across Mud River, just north of New Teakettle Creek, and the two Teakettles carry toward Doboy the entire flow from the head of Mud River. At an hour before low water Old Teakettle takes all of the flow from the head of Mud River, New Teakettle drains only a small portion of Mud River, immediately tributary to its north end, while the flow in Mud River east of New Teakettle Creek is toward Sapelo.

On the flood tide the water from Old Teakettle Creek toward the head of Mud River crowds the east bank of that creek, and passes well into Mud River before it turns to the west and runs along the north bank of Mud River. On the ebb, the return flow from the west end of Mud River is along the south side, west of Old Teakettle Creek. The water from the west, which passes down that creek, turns sharply to the south on reaching the creek and runs down along its west bank. That which passes this creek runs close along its north end and continues toward

Sapelo close along the south side of Mud River. The flow toward the northeast on the Mud River crossing, north of New Teakettle Creek, from half an hour before high water until nearly four hours after high water, runs across the boat channel at quite an angle, while that toward Sapelo, for one hour before to three hours after low water and from Sapelo from three and one-half hours to five and one-fourth hours after low water, is nearly parallel to the boat channel. On this crossing, for the first three hours of the ebb, the top currents run more nearly along the direction of the boat channel, or to the left; while the bottom current runs more to the right, crossing the channel at a bad angle. In the widest part of Mud River, 2¼ miles farther northeast, the surface current on the first three hours of the ebb tends to run off sharply to the right toward the deep pocket along Sapelo Island, while the bottom currents uniformly turn sharply to the left toward the deep pocket from the creek to the west of Mud River. In Mud River, from the black buoy to the sound, the tides flow in on the flood with low velocities, but on the ebb outward with comparatively high velocities. The velocity of flow is greater in Front River on the ebb than on the flood, and is strong enough to prevent any deposition of material in the lower 2 miles of the river.

TIDAL CURRENTS (VELOCITIES).

The maximum mean velocity for the vertical in Mud River, west of Old Teakettle Creek, is about 2 feet per second on the flood, about three hours after low water; and about the same on ebb, about two hours after high water. At the north end of Old Teakettle Creek the maximum mean velocity for the vertical on the flood is about 1.6 feet per second at about two hours after low water in the deep channel on the east side while the corresponding maximum velocity on the ebb is about 1.9 feet per second at two and one-half hours after high water, but in the shoaler channel along the west side of the creek. In the north end of New Teakettle Creek the maximum mean velocity for the vertical toward the north is about 2 feet per second at about half flood. The maximum mean velocity for the vertical toward the south at this place is a little more than 2 feet per second at four hours after high water. On the center of the crossing north of the mouth of New Teakettle Creek on the shoalest part of the channel the maximum mean velocity for the vertical toward Sapelo is about 1.3 feet per second at one hour after high water, but its direction is at least 50 degrees to the right of the line of the crossing. The maximum mean velocity for the vertical of the current toward Sapelo at this place, which follows anywhere near the direction of the boat channel, is about 0.7 foot per second at one hour after low water. The maximum mean velocity for the vertical from Sapelo at the center of this crossing is less than 0.2 foot per second, and at two hours before high water. Farther toward the southeast on this crossing, *i. e.*, about 300 feet from the right bank of Mud River, the velocities toward the north are much greater than on the shoal part of the crossing, particularly while the ebb flow from the upper end of New Teakettle Creek is toward the north.

At one hour after high water the current here crosses the boat channel at an angle of about 50 degrees, and has a mean velocity for the vertical of 2¼ feet per second. An hour later, when the current from New Teakettle Creek has ceased, the mean velocity for the vertical in the same direction at this place is about 2¼ feet per second. But from two hours after high water the current on this crossing dies down rapidly, leaving the water here slack at half ebb. In the channel in Mud River, near the pile beacon, about 2 miles northeast of New Teakettle Creek, the maximum mean velocity for the vertical on the ebb is about 1.65 feet per second at two and one-half hours after high water. The flood currents at this point were not measured, as they were much lighter than those of the ebb. In many cases both bottom and mean velocities were determined, and the mean of a large number of determinations indicates that at most places the bottom velocity can be taken at 85 per cent of the mean velocity for the vertical. No attempt was made to measure the velocity of currents in Front River. It is only necessary to state that for the outer two miles of this river its area is so proportioned to the tidal basin above that neither deposition nor cutting is taking place.

GENERAL NOTES ON TIDAL CURRENTS.

It will be noticed that in Mud River, just north of New Teakettle Creek, the current runs toward Sapelo from half an hour before until nearly four hours after high water, and from one hour before until three and one-fourth hours after low water, or a total of eight and one-half hours. The current runs in the opposite direction for only one and three-fourths hours from about three and one-half hours to five and one-fourth hours after low water. For the other one and three-fourths lunar hours the

water is slack. For the eight and one-half hours the mean velocity toward the northeast is about 0.6 feet per second; while for the one and three-fourths hours toward the south the mean velocity is only about 0.1 foot per second. The total discharge across this line toward Doboy is only about 4 or 5 per cent of that toward Sapelo. Through the north end of New Teakettle Creek the tide runs to the north from low water until two hours after high water, or about eight hours, against three and three-fourths hours toward the south. Moreover, the water is deeper during the northward than during the southward flow, while the maximum velocities are about the same, No direct comparison of ebb and flood discharges was made in Old Teakettle Creek. It was observed, however, that the flood from the south ran up on both sides of the shoal at the mouth of the creek, but mainly through the deeper channel along the east side. On the contrary, the current to the south, while it is very strong in the shoaler channel to the west, is weak in the deeper one. Without doubt much more water comes up Old Teakettle also than goes back again. The location of the contours on the river bottom at the mouth of Old Teakettle Creek would indicate that an excess flow toward the north could be expected. At the head waters between Front River and Scott Creek observations made near high water failed to show any tendency toward an excess flow from one river to the other, although high water in Scott Creek is probably fifteen minutes earlier than in the head of Front River. The channel connecting Scott Creek with Mud River is, however, very slight. It is about 700 or 800 feet long, and is only 10 or 12 feet wide on top. The sides of this connecting channel are very steep, coming together in a deep narrow drain at about 1 foot above mean low water.

POSITION OF A SHIP CHANNEL.

The possible lines of improvement in the direction of a 12-foot ship channel between Doboy and Sapelo are (1) by the way of New Teakettle Creek and Mud River; (2) by the way of New Teakettle Creek and Front River; and (3) by the way of Old Teakettle Creek and Front River. Of course it is possible to develop other routes, but no other route is practicable, except at a cost to far exceed that on any one of the routes mentioned above.

Route No. 1.—A cut on any possible line through Mud River would be at least 24,000 feet long. The depth of such a cut would, in the worst places, exceed 7 feet, and would average for the whole 24,000 feet about 5.3 feet deep. From a consideration of the directions and velocities of the current and the materials forming the bed of Mud River it is entirely out of the question to presume that a cut to the required depth from the mouth of New Teakettle Creek to Sapelo Sound would remain open even while it was being made. The bottom is soft, and the cross currents would be certain to fill it to 7 or 8 feet at mean low water in a very short time. It is also out of the question, in my opinion, to attempt to increase the currents through Mud River in line of such a cut by spur jetties, except at an expense much greater than the present or prospective commerce of the route will warrant. That part of this route in New Teakettle Creek only would keep open to the proper depth after being dredged without the aid of works of contraction

Route No. 2.—The route by the way of New Teakettle Creek and Front River should, in my opinion, cross Mud River from the mouth of New Teakettle Creek in a northwesterly direction about in line with △ Q and a point 400 feet southwest from ⊙r_8. At the northwest side of Mud River the line should curve to the right for about 2,400 feet, at which point it would cut into the nameless creek between Mud River and Front River. From this point the line should extend into Front River at about 50 feet west from △ IX on a magnetic north-and-south line, just half a mile in length. In order to carry 12 feet at mean low water from this point to Sapelo Sound it would only be necessary to lower a single shoal 250 feet long to the depth of about 1 foot.

The following table shows the depths of water below and the heights of the bank above mean low water on this route, between the 12-foot curve from Doboy and the same curve from Sapelo, at points 400 feet apart:

Distance.	Depth at or elevation above mean low water.	Remarks.	Distance.	Depth at or elevation above mean low water	Remarks.
Feet.	*Feet.*		*Feet.*	*Feet.*	
0	−12.0	Creek 400 feet wide.	8,000	+ 6.9	Crossing marsh.
400	−10.3		8,400	+ 6.9	Do.
800	−14.2	Creek 320 feet wide.	8,800	+ 6.9	Do.
1,200	−15.2		9,200	+ 7.0	Do.
1,600	−12.8		9,600	+ 7.0	Do.
2,000	−13.8	Creek 350 feet wide.	10,000	−12.9	Creek 350 feet wide.
2,400	−10.7	Creek 325 feet wide.	10,400	−12.0	Do.
2,800	−25.0	Creek 300 feet wide.	10,800	−12.0	Creek 325 feet wide.
3,200	−22.1		11,200	+ 7.0	Crossing marsh.
3,600	−12.0		11,600	+ 7.1	Do.
4,000	− 9.7	Creek 340 feet wide.	12,000	+ 7.1	Do.
4,400	−14.8		12,400	+ 7.1	Do.
4,800	−21.0	Creek 320 feet wide.	12,800	−15.8	River 350 feet wide.
5,200	−12.0	Creek 500 feet wide.	13,200	−17.0	River 450 feet wide.
5,600	− 7.0	Crossing Mud River.	13,600	−16.0	River 600 feet wide.
6,000	− 0.7	Do.	14,000	−14.8	River 700 feet wide.
6,400	− 1.4	Do.	14,400	−13.8	River 650 feet wide.
6,800	− 2.4	Do.	14,800	−12.0	River 600 feet wide.
7,200	− 4.0	Do.	15,000	−11.2	River 600 feet wide.
7,600	+ 6.9	Do.	15,200	−13.5	River 550 feet wide.

The necessary cuts on this route, in order to give 12 feet at mean low water, would be as follows: From 0 to 800 feet a cut on an average of 1.7 feet deep would be required. From 800 to 2,300 feet the water is now from 12 to 15.5 feet deep. From 2,300 to 2,600 feet a cut about 1.5 feet deep would be necessary in order to give the required depth. From 2,600 to 3,600 feet the water is now from 12 to 24 feet deep. The creek bottom from 3,600 to 4,100 feet would need lowering by about 2 feet. For the next 1,100 feet from 12 to 22 feet is found at low water. From 5,200 to 7,500 feet (crossing Mud River) the water is from 0.5 to 12 feet deep. A cut for this 2,300 feet would average about 8.7 feet deep. For the next 2,300 feet, or to the edge of the intervening creek, a cut through the marsh would average about 19 feet deep. In the channel of the creek mentioned, from 9,800 to 11,000 feet, there is found for 800 feet a sufficient depth of water. For the next 1,400 feet a cut through the marsh to the bank of Front River about 19 feet deep would be necessary. This line strikes Front River at about 12,500 feet and deep water in that stream at 5 feet farther. For the next 2,250 feet the water is from 12 to 18 feet deep, beyond which point a shoal 250 feet long would require deepening about 1 foot. The total length on this line between the extreme 12-foot areas would be about 15,050 feet. Of this distance 6,650 feet carry 12 feet or more of water, while the total length of the necessary cut would be about 8,400 feet. Of the total length of cut 3,700 feet only would be through the unbroken marsh, while 4,700 feet would be in the bed of one of the four streams through which the route passes. For the 3,700 feet through the marsh the cut would average 19 feet deep.

Across Mud River, a distance of 2,300 feet, the cut would average 8.7 feet deep, while for the remaining 2,400 feet the depth of the cut would average about 2.5 feet. A cut made through the materials composing this marsh would stand without caving or sliding, with side slopes of 1 on 2. The cubic contents, in place, of such a cut 12 feet deep at mean low water and 100 feet wide on the bottom, with side slopes of 1 on 2, as above stated, would be slightly less than 475,000 cubic yards. Such a cut across Mud River on the line proposed would be at right angles to the prevailing currents in that stream. In order to prevent a cut at this place from filling up, it would be necessary to build a dam or training wall entirely across Mud River, parallel for the most part to the axis of the cut. Such a training wall should be on a wide base and should be brought up to about 5 feet above mean low water, except near the mouth of New Teakettle Creek, where it should be left down to about 6 feet below mean low water for a width of about 100 feet. Such a wall would not only serve to concentrate the flow in the direction of the cut on this crossing, but would prevent heavy northeast storms from filling up the cut. A gap 100 feet wide by 11 feet deep in the wall would serve as a channel for smaller boats, and also act as a safety valve against excess pressure from either direction. The opening being on the line of the present deep pocket along the right bank of Mud River, it would not be expected to do any harm to the channel. In order to properly direct the flow of water through the cut across Mud River, it would doubtless be necessary also to con-

struct, on the opposite side of the cut, a low training wall on a wide base extending from the north side of the river about 1,800 feet toward the head of New Teakettle Creek. The upper end of Mud River being cut off from Sapelo Sound, and the excess flow being toward the north, will increase the flood as well as the ebb velocities in New Teakettle Creek and give a much stronger ebb flow toward the north in the cut than toward the south. The dividings between Doboy and Sapelo on the line of this route would doubtless range from near the mouth of Marsh Creek to the nameless creek in the middle of the deep cut, being at the latter place a greater part of the flood and at the junction of Mud River and New Teakettle Creek during a greater part of the ebb.

In order to increase the flow of Front River as much as possible between the mouth of such a cut and Sapelo Sound, the bed of the nameless creek across which the route would run should be employed as a reservoir tributary to Front River only. This creek could be used as a dumping ground for the cut for its whole length, after which a pile dam should be placed across the creek at some shoal point as remote from the cut as possible, completely separating the middle of the cut from Mud River. The banks of neither New Teakettle Creek nor the outer end of Front River, being well protected by bunch oysters, will be materially eroded by any amount of water which may be thrown into these streams by opening up the cut and placing a dam across Mud River. It would not be necessary, in my opinion, to dredge out the cut so wide nor so deep between New Teakettle Creek and Front River. A much smaller cut, as one 9 feet deep at low water and 50 feet wide on the bottom by 100 feet wide on top, would, with a dam across Mud River as mentioned above, enlarge itself to the required width and depth in a few months' time. The cubic contents of this smaller cut, in place, between New Teakettle Creek and Front River, including the necessary cuts in both of these streams, to 12 feet at mean low water and 100 feet wide on the bottom will be only about 225,000 cubic yards, or less than half the contents of the proposed cut 12 feet deep. Even if the cut were made at once 12 feet deep at mean low water and 100 feet wide on the bottom, and the dam across Mud River raised only high enough to keep the cut on that crossing open, it could be confidently expected that within a few years the cut between New Teakettle Creek and Front River would wash out to at least the present dimensions of the former stream; that is, to at least 300 feet wide on the top and 150 to 200 feet wide on the bottom, and 12 to 18 feet deep. In my opinion, the materials eroded from the smaller cut would not be deposited in any place in or adjacent to the channel in either direction. If such a cut once well started will enlarge itself naturally, and if the eroded materials will not interfere with the channel in other parts of the route, it follows that it would be unwise to expend a sum sufficient to cut at once the ship channel to its proper size. Nature will do the work as well, and at no expense.

Route No. 3.—On the route between Doboy and Sapelo, by the way of the Old Teakettle Creek and Front River, beginning with the 12-foot curve from Doboy Sound, a cut would be required in the wide-spread of Old Teakettle Creek 2,600 feet long, averaging 3.2 feet deep. For the next 7,700 feet to the head of Old Teakettle Creek, from 12 feet to 33 feet of water are found. From this point to the north side of Mud River at Scott Creek, a distance of 2,800 feet, a cut would be necessary for the entire distance, averaging 3.3 feet deep. For the next 4,200 feet to a point in Front River 300 feet south of △ XII, a cut about 19.4 feet deep should be made. From the cubic contents of this heavy cut the present bed of Scott Creek and Front River at the few places touched would take out but comparatively little. For the next 4,100 feet the river bottom would necessarily require lowering from 0 to 12 feet, an average, no doubt, of 6 feet. Then follows a pocket 1,700 feet long and from 12 to 20 feet deep, after which a shoal about 700 feet long, carrying about 10 feet of water, is found. Then comes 400 feet of deep water and 300 feet of shoal, after which a stretch of 4,000 feet, carrying 12 to 24 feet of water, is met with before the final shoal of route No. 2, 250 feet long, is reached. On this route is a total length of about 15,000 feet of shoal with about 13,800 feet of deeper water. The cubic contents of a cut on this route would be far in excess of that on route No. 2. In addition to the excavation required, a high training wall would be necessary across Mud River just east of the mouth of Old Teakettle Creek, and a number of long spur jetties would be necessary to properly concentrate the water in a channel across the wide-spread of Old Teakettle Creek.

Compared with the advantages of route No. 2, the merits of routes Nos. 1 and 3 disappear.

COMMERCE.

The commercial value of a ship channel between Doboy and Sapelo is, in the main, measured by the amount of a certain class of exports and imports of the port of Darien, Ga. The following table, collected from various sources, shows approximately the commerce of Darien:

Exports and imports for the port of Darien, Ga., for the fiscal year ending June 30, 1891.

Articles.	Amount.	Tons.	Value.
Naval stores ....barrels..	24,660	5,500	$160,650
Cotton ....bales..	1,000	250	40,000
Lumber ....feet..	83,234,000	160,000	749,106
Rice ....bushels..	100,000	2,500	100,000
Miscellaneous	....	3,000	100,000
Total........	....	171,250	1,149,756

This commerce of this year, as compared with that for the previous year, shows a slight increase in the quantity of lumber, while the total tonnage of naval stores, cotton, rice, and miscellaneous goods shows an increase of about 25 per cent.

The value of a 12-foot channel for seagoing vessels between Doboy and Sapelo over that of a 7-foot channel is measured by only a certain proportion of the lumber passing the port of Darien, as given in the above table. The need of such a ship channel from Doboy to Sapelo is to give through the latter sound a better outlet to the sea for heavy vessels loaded with lumber than now exists over the shoal bar at the entrance of Doboy Sound. The mayor of Darien reports that of the 83,234,000 feet of lumber passing Doboy for the last fiscal year only 56,811,000 feet were carried to sea over the Doboy Bar. Of the remainder 16,074,000 feet were towed or drifted to the south and west to sea through St. Simon Bar, while 10,349,000 feet were towed to the north in rafts and found an outlet through Sapelo. If deep-draft ships loading at Darien or Doboy could go to sea through the proposed ship channel and Sapelo Sound they would drive from the principal lumber port of the South Atlantic coast the shallower coasting boats which now carry the bulk of the lumber exported. Deep-draft boats will carry this lumber at a figure much lower per thousand feet than now prevails among the boats of lighter draft which are able to pass Doboy Bar in safety. It is not unreasonable to suppose that soon after the opening of such a ship channel from Doboy to Sapelo, in connection with the improvement of Darien River between Darien and Doboy, which is now going on, at least 60,000,000 to 75,000,000 feet of lumber will annually find its way to sea through this route. A saving in freight of only 50 cents per thousand feet of lumber by deeper-draft boats through Sapelo would no doubt repay the cost of the construction of such a ship channel within three or four years after its completion.

I wish here to express my obligations to Mr. J. L. Van Ornum, assistant engineer, who served in this survey in the capacity of transit man, for his hearty coöperation and valuable assistance.

Very respectfully, your obedient servant,

GEO. W. BROWN,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 12.

[Printed in House Ex. Doc. No. 41, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF INSIDE ROUTE BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA, WITH A VIEW OF OBTAINING A STEAMBOAT CHANNEL OF SEVEN FEET DEPTH AT MEAN LOW WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 25, 1890.

GENERAL: In compliance with Department letter dated September 20, 1890, I have the honor to submit the following report of a preliminary examination of "the inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water."

The location of this route is shown by a dotted line on Coast Survey charts Nos. 156 and 157, to which I respectfully refer for details. Throughout the greater portion of the route are found ample widths and depths for steamboat navigation. Depths less than 7 feet at mean low water are found at the following places: (1) Romerly Marsh; (2) Mud River;

(3) Little Mud River; (4) Jekyl Creek; (5) The Dividings. In Frederica Creek, about 1 mile above Frederica Landing, the channel is obstructed by oyster beds. Some slight shoaling has also taken place at the mouth of Adams Creek.

At two of the localities, viz, Romerly Marsh and Jekyl Creek, work has already been done by the United States. There is now a mean low-water depth at the former place of 4.8 feet, and at the latter of 5.5 feet. For detailed descriptions of the condition of these localities, I respectfully refer to my last annual report.

At Mud River there is for nearly 4 miles a mean low-water depth of only about 4 feet. Near the southern end of Little Mud River there is a shoal with a depth of about 6 feet at mean low water. At "The Dividings," near the mouth of Crooked River, there is a depth of about 5.5 feet at mean low water.

I have not been able to obtain any reliable information relative to the value of the commerce passing through this route. Two steamers per week ply on this route between Fernandina and Savannah, fourteen per week between Brunswick and river points, and one daily between Brunswick and Fernandina. Vessels are often towed over portions of this route to avoid rough weather at sea, and it is also navigated by many small craft carrying rice, naval stores, oysters, and fish. The value of the commerce passing through this route has been variously estimated at from $200,000 to $400,000 per annum.

Two important points on this route have already been deemed worthy of improvement by the United States, viz, Romerly Marsh and Jekyl Creek, and I am of the opinion that for all of the reasons stated the obstructions to navigation at the other points mentioned should also be removed.

Among other advantages to be derived from the proposed improvement are that steamers now plying on this route could run on schedule time, and vessels that now have to go to sea could be towed to coastwise ports over this route, thus avoiding the risk of encountering strong weather at sea.

The military importance of this route has already received attention, and need not be stated here.

The estimated cost of surveys upon which to base plans and estimates of improvements is $1,000.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 28, 1890.

Respectfully submitted to the Chief of Engineers.

In view of the facts and reasons set forth in the report of the local engineer of November 25, 1890, and of my own personal knowledge, I consider the inside route between Savannah, Ga., and Fernandina, Fla., worthy of improvement, including the present and prospective needs of commerce.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

SURVEY OF INSIDE ROUTE, BETWEEN SAVANNAH, GEORGIA, AND FERNANDINA, FLORIDA, WITH A VIEW OF OBTAINING A STEAMBOAT CHANNEL OF SEVEN FEET DEPTH AT MEAN LOW WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., November 25, 1891.

GENERAL: In accordance with the requirements of section 17 of the river and harbor act of September 19, 1890, and instructions from the Chief of Engineers, dated November 29, 1890, I have the honor to submit herewith my report upon the survey of the "inside route between Savannah, Ga., and Fernandina, Fla., with a view of obtaining a steamboat channel of 7 feet depth at mean low water," together with a project for its improvement and an estimate of the cost of the same. A brief description of the aim of the proposed improvement and some facts relating to its commercial importance are given in my report upon the preliminary examination, dated November 25, 1890, to which I respectfully refer.

The location of this route is shown by a dotted line on current Coast Survey Charts Nos. 156 and 157, to which reference is respectfully made for details in connection with the following description. The route leaves the Savannah River by St. Augustine Creek and following Wilmington River, reaches Romerly Marsh, through which two routes exist—the old one through Romerly Marsh Creek, very crooked and narrow, and almost impracticable at low water, and the new route through Dead Mans Hammock Creek and the dredged cut connecting the same with Wassaw Creek, through the latter and Odingsell River to Adams Creek where it joins the first route. From Romerly Marsh the route traverses the following streams, or portions of them, viz, Adams Creeek, Vernon River, Ogeechee River, Florida Passage, and Bear River; then crosses St. Catherines Sound and follows North Newport River (or Walburg Creek), Johnsons Creek, and South Newport River into Sapelo Sound. In all parts of the route just described, south of Romerly Marsh, the depths exceed 7 feet at mean low water, ranging generally from 10 to 20 feet and often exceeding the latter depth. On leaving Sapelo Sound, the most serious obstruction of the entire route is found in the long stretch of shallow water in Mud River. For a distance of over 3.5 miles the depth is less than 7 feet; the mean depth is 5.8 feet, and the least depth 4.8 feet, all referred to mean low water. From Mud River the channel follows New Teakettle Creek, crosses Doboy Sound, and enters North River, thence through a portion of Rockdedundy River, reaches Little Mud River, in which there is a shoal of small extent carrying slightly less than 7 feet at mean low water. Crossing Altamaha Sound the channel continues through Buttermilk Sound and Frederica Creek into St. Simon Sound. About 1 mile north of Frederica Landing the channel is narrow and is partially obstructed by oyster beds.

Entering Jekyl Creek from St. Simon Sound two shoals are encountered, one just outside the entrance and the other inside, at the point where the creek widens. The least mean low-water depths on those shoals are 4.8 feet on the former and 5.3 feet on the latter. The route crosses St. Andrews Sound by a detour seaward around the middle ground, and thence by way of Cumberland River and Cumberland Sound reaches Fernandina, Fla.

From Jekyl Creek southward the depths are ample, exceeding in

most places 10 feet at mean low water, and navigation is easy, except at one point, known as "The Dividings," at the mouth of Crooked River. At that point a sharp turn of more than 100 degrees is made by the channel in passing Horseshoe Shoal. The least channel depth is, however, fully 7 feet at mean low water, and greater depths are found on either side of the shoal. Were the channel properly marked by ranges and buoys no difficulty in navigating it should be experienced.

The distance from Savannah to Fernandina by the inside route just described is about 160 miles.

Touching at Darien en route increases the distance by about 20 miles, and at Brunswick by about 12 miles.

The survey of the inside route was made under my direction in April and May, 1891, by Mr. George W. Brown, assistant engineer.

Detailed surveys were made at the following points: Romerly Marsh, Mud River, Little Mud River, Jekyl Creek, and "The Dividings."

The methods employed in the survey are similar to those described in my report upon the survey of the inside route between Doboy Sound and Sapelo Sound, dated October 5, 1891, to which I respectfully refer.

ROMERLY MARSH.

Wassaw Creek route.—With a view to determining the best route for an improved channel through Romerly Marsh, two lines were surveyed, viz, the present channel through the dredged cut and Wassaw Creek and a route from Romerly Marsh Creek through Habersham Creek, the head of which is separated by a narrow strip of marsh land from Odingsell River.

The first-named route was opened under the direction of Congress between the years 1883 and 1886 by the dredging of a cut through the marsh between Dead Mans Hammock Creek and Wassaw Creek, and by deepening the latter at Shoals No. 1, No. 2, and No. 3. For details in reference to its construction, I respectfully refer to the annual reports of the Chief of Engineers, U. S. Army. The total length of continuous cut is 4,117 feet, 3,547 feet of which are through solid marsh and 570 feet at the head of Wassaw Creek. The cut is from 90 to 110 feet wide at the low-water and about 140 feet wide at the high-water line. The surface of the marsh is at about the level of mean high water, except at the southern end of the cut, where it joins Wassaw Creek in a low marsh, scarcely half of which rises above the level of mid-tide. The depth of water in the cut exceeds 7 feet at only one point, 1,100 feet from the northern end, where it is 7.1 feet. The mean depth throughout the cut is 5.8 feet, and the least depth is 5.2 feet, at points about 800 feet from the northern end and 600 feet from the southern end. For a length of about 200 feet on Shoal No. 3, and 800 feet on Shoal No. 2 the depth is less than 7 feet, the minimum mean low-water depths being 6.7 feet on the former and 6.3 feet on the latter.

The material at the bottom of the cut is mud, clay, and fine sand, mud and sand predominating. The banks are of mud and a little sand, except at Dead Mans Hammock, where they are of clear, fine sand. At Shoal No. 3 the bottom is of sand and clay or hard mud. At Shoal No. 2 it is softer, containing more mud.

The mean range of tide in the cut, as approximately determined by only a few observations, is about 6.8 feet. The tidal currents are very irregular, owing to the fact that the tides from Wassaw Sound and Ossabaw Sound meet near the southern end of the cut. Current observa-

tions were made on May 8, during a spring tide with a range of 9.1 feet, the mean tidal range being 6.8 feet. The results obtained do not therefore correspond to mean tidal conditions. At low water, on the date considered, an area of slack water prevailed throughout the southern half of the cut and the upper two-thirds of a mile in Wassaw Creek, from which area ebb currents still ran slowly toward the north and south. An hour later the currents had been reversed, and slow flood currents were running both in the cut and the creek toward a slack-water area at the point where the cut and the creek meet. For a time the current from the north then overpowers that from the south and drives the area of slack water down the creek about 3,000 feet, where it remains until about half tide, when the low marshes and mud flats at the head of Wassaw Creek become flooded and the currents flow with increased velocities from both directions to cover the greatly increased area, and meet at the mouth of the large branch of Wassaw Creek about 600 feet from the cut.

Those conditions prevail until nearly high water, when the current from Wassaw Creek predominates for a time and drives the slack-water area back into the cut about 1,000 feet. Half an hour after high water the currents change and until half ebb divide at the mouth of the large branch of Wassaw Creek and flow in both directions toward the sea. After this Wassaw Creek alone drains its large branch, as well as the southern end of the cut, and the slack-water area moves gradually northward until it reaches the middle of the cut. At one hour before low water, however, the currents again divide at the mouth of the large branch, and finally disappear at slack low water. In the cut the maximum flood velocity was found to be about 2.6 feet per second at three hours after low water, with a bottom velocity of about 2 feet, and the maximum ebb velocity to be about 1.2 feet per second at two hours after high water, with a bottom velocity of about 1 foot. In Wassaw Creek below the large branch the maximum flood velocity was only 0.9 of a foot per second at one hour before high water, with a bottom velocity of 0.7 of a foot, and the maximum ebb velocity was 1.85 feet per second at two and one-half hours after high water, with a bottom velocity of 1.7 feet. The condition of slack water which prevails at the head of Wassaw Creek and the southern end of the cut for at least one-half of the time is a fruitful source of shoaling, and the pocket which existed at the head of the creek with a low-water depth of 12 feet when the cut was opened, has shoaled so that the present depths are only from 5 to 6 feet. Shoaling has also taken place throughout the entire cut, owing partly to the degradation of the banks and partially to the material brought in by the strong flood currents which the weaker ebb is unable to remove. The mean depth in the cut at its completion was 7.2 feet, and the least depth 6.1 feet. At present the mean depth is but 5.8 feet and the least depth 5.2 feet, showing a fill in the cut alone of over 20,000 cubic yards of material. The cut has widened at the high-water line by from 5 to 25 feet in the northern half, and from 20 to 40 feet in the southern half. The shoaling was very rapid during the first two years after the completion of the cut. Since then it has been slower, but continuous at the rate of about 0.2 of a foot per year.

The permanent improvement of this channel can be accomplished only by continuous dredging, since there is no feasible method of changing the tidal conditions so as to promote natural scour.

The quantities of material necessary to be removed by dredging to give a depth of 7 feet at mean low water in a channel 50 feet wide at

the bottom, with side slopes not greater than 1 on 2, are as follows, viz:

	Cubic yards.
In the cut proper	35,000
At Shoal No. 3	4,000
At Shoal No. 2	5,000
Shoal between Nos. 2 and 3	3,000
Total	47,000

Estimating the cost of dredging at 25 cents per cubic yard in place, and allowing 15 per cent for engineering and contingencies, the total cost of the improvement would be, in round numbers, $13,500.

There is, however, no reason to believe that the new channel would be any more permanent in character than it has proved to be in the past. The total amount of material to be dredged, as given above, represents approximately the amount of filling that has taken place during the past five years. Should the shoaling continue at the same rate, there would be required an annual expenditure of from $2,000 to $3,000 to maintain the improved channel.

ESTIMATES.

Dredging 47,000 cubic yards in place, at 25 cents	$11,750.00
Engineering and contingencies, 15 per cent	1,762.50
Total	13,512.50
Estimated annual expenditure for maintenance, $2,500, interest at 5 per cent on	50,000.00
Aggregate	63,512.50

Habersham Creek route.—The second route surveyed through Romerly Marsh is by way of Habersham Creek, and a proposed dredged cut through the narrow strip of marsh between the head of the creek and Odingsell River. Habersham Creek branches from Romerly Marsh Creek about 1.5 miles west of the mouth of Dead Mans Hammock Creek and extends nearly due south, almost cutting across the narrowest portion of the marshes lying between Romerly Marsh Creek and Odingsell River. This route will form the shortest available one between the mouth of Romerly Marsh Creek and the head of Adams Creek, with greater probabilities of self-maintenance than any other. The distance between the above-mentioned points via the present cut and Wassaw Creek is 8.3 miles; through the "Old Marsh" route it is 4.3 miles; while by the Habersham Creek route it would be only 3.3 miles.

The main stem of the creek is 4,400 feet long, it is nearly straight, and varies in width from 75 to 150 feet at the low-water and from 125 to 200 feet at the high-water line. The mean low-water channel depths vary between 3.8 feet and 7.9 feet, the average depth being 6 feet. The bottom and banks are composed principally of soft or stiff mud.

The creek has two branches, the larger of which continues toward the south, with an average width of 80 feet and a low-water depth of from 1 foot to 4 feet, and heads at a point distant only 1,000 feet from Odingsell River. The mean range of tide in Habersham Creek has never been accurately determined. The observations made give it between 6.8 and 7 feet.

Flood currents prevail until a short time after high water and ebb currents until a short time after low water. Velocities were observed only during flood tide, and were found to reach a maximum of about 1.2 feet per second, with a bottom velocity of about 1 foot. It is probable that the ebb velocities do not differ much from the flood.

The improvement of this route would require the deepening of the main stem of the creek by the removal of about 12,000 cubic yards of material by dredging, and the opening of a dredged cut following approximately the course of the larger branch and cutting through the marsh on the shortest line to Odingsell River by the removal of about 120,000 cubic yards of material, making a total of 132,000 cubic yards.

If a less tortuous route be selected, the total amount of material to be removed by dredging would be increased to about 150,000 cubic yards. The changes in the tidal conditions that would follow the opening of the proposed cut are difficult to predict, owing to the meager information available in regard to the relative elevations and slopes of the water surface at different stages of the tide. One determination of elevations made April 7, 1891, shortly after half flood, gave the elevation of the water surface in Odingsell River as 6.4 feet above mean low water, and that at the head of the large branch of Habersham Creek as 6.1 feet above the same plane. At the head of the main stem of the creek it was 6.3 feet. An elevation corresponding to that in Odingsell River would therefore probably be found near the middle of the main stem of the creek. Those conditions, if maintained after the opening of the cut, would cause the tides to meet near the middle of the main stem of the creek. A single determination at only one stage of tide cannot, however, be supposed to render true mean results which may be quite different from those given.

There is at the head of Romerly Marsh Creek an area of low marshes and mud flats forming a large tidal reservoir. It is possible that were the cut opened, it and Habersham Creek would be called upon for service in filling and emptying this basin in conjunction with Romerly Marsh Creek, thus determining the meeting of the tides at the junction of those two creeks—a condition favorable for the maintenance of ample depths in the creek and cut. These advantages of tidal flow would be augmented by the closing of the Old Marsh route at a point near Adams Creek, so that the flow to and from the tidal basin before mentioned might be forced through the new channel. This would require the construction of a closing dam about 200 feet long, rising to a height of 3 feet above mean high water in an average mean low-water depth of about 5 feet.

Such a dam of log or brush mattresses loaded with stone or shells up to mean low water and of stone and shells alone above that level would cost about $8,000.

ESTIMATES.

Dredging, 150,000 cubic yards, in place, at 25 cents	$37,500
Mattresses, 4,000 square yards, at 75 cents	3,000
Stone, 1,200 cubic yards, at $3.50	4,200
Shells, 1,000 cubic yards, at $1	1,000
Total	45,700
Engineering and contingencies, 15 per cent	6,855
Estimated annual expenditure for maintenance $500, interest at 5 per cent on	10,000
Aggregate	62,555

The construction of the closing dam may not be necessary, in which case the total cost, including engineering and contingencies, would be reduced to $53,555. The route described would be shorter than the present route through Wassaw Creek by about 5 miles, and would possess the additional advantage of not requiring frequent expenditures for maintenance.

Had not the opening of the Wassaw Creek route been made mandatory by Congress that route would not have been selected by the engineer. In view of all of the foregoing, it is therefore recommended that the present route be abandoned, and the route through Habersham Creek be selected for improvement.

MUD RIVER.

The present channel between Doboy and Sapelo sounds passes through Mud River and New Teakettle Creek. In the latter ample depths are found, ranging from 10 to 20 feet, but in Mud River extensive shoals are encountered, with minimum depths at various points in the best channel of from 4.7 to 5.3 feet at mean low water. The distance through Mud River from the head of New Teakettle Creek to Sapelo Sound is about 4 miles. The widths are excessive, being about 5,800 feet at the mouth, widening to 6,400 feet 2 miles above, and then gradually narrowing to about 1,700 feet just below the entrance to New Teakettle Creek. The present channel, after leaving New Teakettle Creek, crosses the river over a shoal 1,500 long, with a minimum depth of 4.8 feet, and enters a deep pocket 3,000 feet long close to the western shore. Then follows a distance of 11,000 feet, in which the depth is less than 7 feet, the minimum depth being 5.3 feet.

At the mouth of the river there is another shoal 4,500 feet long with a minimum depth of 5.2 feet. East of the channel are wide mud flats with depths of but 1 or 2 feet and with large areas showing above mean low water. Near the mouth there is a deep pocket along the eastern shore, but it shoals into the mud flats just described and is rapidly filling up, former depths of 16 feet being reduced to present ones of only 8 or 9 feet.

The material composing the river bottom is very soft mud, rendered sticky in places by the admixture of clay. The mean range of tide in Mud River, as approximately determined by the limited number of observations available, is 7.5 feet. The tidal currents are of moderate velocity, and near the upper mouth of New Teakettle Creek are very irregular. Their characteristics are exhibited in the following table:

Tidal hours.	Stage.	Mouth New Teakettle Creek.	New Teakettle Creek.	Mud River above New Teakettle Creek.	Mud River below New Teakettle Creek.
XII	L. W	Slack water	Slow ebb	Slack above; slow ebb below.	Slow ebb.
I		Moderate flood branching N. and S. in Mud River.	Moderate flood	Slow flood	Moderate ebb above; slow flood below.
II		Strong flood branching N. and S. in Mud River.	Strong flood	Moderate flood	Moderate ebb above; moderate flood below.
III	Half flood.	do	do	Strong flood	Slack above; moderate flood below.
IV		Moderate flood turning S. in Mud River.	Moderate flood	do	Moderate flood.
V		do	do	Moderate flood	Do.
VI	H. W	Slow flood turning N. in Mud River.	Slow flood	Slow ebb	Slow ebb above; slow flood below.
VII		do	Slow flood above; slow ebb below.	Moderate ebb	Strong ebb.
VIII		Slack water	Moderate ebb	Strong ebb	Do.
IX	Half ebb.	Strong ebb from S.	Strong ebb	do	Slack above; moderate ebb below.
X		do	do	do	Do.
XI		Moderate ebb from N. and S.	do	Slack water	Do.
XII	L. W	Slack water	Slow ebb	Slack above; slow ebb below.	Slow ebb.

It will be seen from the table that in Mud River below New Teakettle Creek there is found a slow ebb current at low water. For three hours there follows an area of slack water, gradually moving up stream, with ebb currents above and flood currents below it. For the succeeding two hours moderate flood currents prevail throughout, and at high water there is again an area of slack water, with slow ebb currents above and slow flood currents below. For two hours after high water strong ebb currents prevail. For the three succeeding hours there is an area of slack water in the upper portion, from which moderate ebb currents are flowing toward the Sound. At low water the cycle of changes begins anew. There are therefore seven hours out of twelve during which an area of slack water exists in some portion of Mud River, with slow or moderate currents in other portions, and only two hours during which strong currents exist, viz, the ebb currents for two hours after high water. At the mouth of New Teakettle Creek slack water occurs at low water. For three hours following the strong flood currents flow to the north and south on entering Mud River. For the next two hours they turn to the south only, and at high water and for two hours thereafter they turn to the north slowly and die out in high water slack. During the third and fourth hours after high water strong ebb currents enter the creek from the south; from that time until low water slack moderate currents from both north and south meet in the mouth of the creek.

During high water slack in the creek strong ebb currents are flowing across its mouth in Mud River. In the north end of New Teakettle Creek the maximum flood velocity is about 2 feet per second, with a bottom velocity of 1.7 feet at half flood. The maximum ebb velocity is about 2 feet per second at four hours after high water. At the shoalest part of the Mud River crossing the maximum ebb velocity is about 1.3 feet per second at one hour after high water, but the trend of the current is about 50 degrees away from the axis of the channel. The maximum ebb velocity when the water flows in the direction of the channel is only about 0.7 of a foot per second. The maximum flood velocity in the direction of the channel is only about 0.2 of a foot per second. Close to the mouth of New Teakettle Creek the ebb current in Mud River reaches a velocity of about 2.5 feet per second, but its direction makes an angle of nearly 50 degrees with the axis of the channel. In the channel of Mud River, half way between the mouth of New Teakettle Creek and Sapelo Sound, the maximum ebb velocity is about 1.6 feet per second. The flood currents were not measured at that point but appeared to be much weaker than the ebb. The channel through Mud River may be improved: (1) By dredging alone; (2) by dredging aided by works of contraction.

A dredged channel through the soft material composing the bottom of Mud River would soon be partially filled by material washed in by storms and cross currents. It would therefore be necessary to resort to dredging at frequent intervals in order to maintain the necessary depths. There are three shoals requiring deepening, which may be designated as the upper shoal, at the crossing from New Teakettle Creek; the middle shoal, near the mouth of the small stream entering Mud River from the west, and the lower shoal near the river's mouth. The upper shoal is about 1,500 feet long, with a minimum mean low-water depth of 4.8 feet and an average depth of 5.6 feet. The dredging of that shoal to a depth of 7 feet at mean low water and a bottom width of 50 feet will require the removal of about 8,000 cubic yards of material. The length of cutting at the middle shoal may be shortened one-half by cutting

across from the present channel to the deep water at the mouth of the small creek entering from the west. The length of cut on that line will be about 5,200 feet. The least depth of water is 3.4 feet and the average depth 5.3 feet. The deepening of that shoal will require the removal of about 30,000 cubic yards of material. To deepen it to 7 feet at mean low water on the line of the present channel will require the removal of about 35,000 cubic yards of material. The lower shoal is about 4,500 feet long, with a minimum depth of 5.2 feet and an average depth of 6 feet. The deepening of that shoal will require the removal of about 17,000 cubic yards of material, making a total of 55,000 cubic yards. It is impossible to predict the rate at which such a dredged channel will be filled by transported material, but experience gained in dredging at other places in similar material shows that the deterioration of the channel will doubtless be very rapid during the first two years. In that time it is probable that one-half of the original increase in depth will be lost. After that the shoaling will be less rapid. There will probably be little error in assuming that in one year after the dredged channel is completed an amount of material equal to one-third of that originally removed will have found its way into the cuts, to be again removed. The quantities of material requiring removal in succeeding years will doubtless decrease little by little, but it can not be assumed that a dredged channel in Mud River will ever be self-maintaining.

ESTIMATE.

Dredging, 55,000 cubic yards, in place, at 25 cents	$13,750.00
Engineering and contingencies, 15 per cent	2,062.50
Total	15,812.50
Annual expenditure for maintenance $4,000, equal to 5 per cent interest on	80,000.00
Aggregate	95,812.50

Should contracting works be constructed to maintain the dredged channel, the currents that will be mainly effective in maintaining the increased depths in the upper portions of the river are the strong ebb currents that prevail for two or three hours after high water. The contraction of the waterway necessary for the proper control of the currents and the maintenance of the channel involves the construction of about 9,500 linear feet of spur dams. They should have a wide foundation, to insure stability on the yielding bottom, and should be brought up to the level of half tide, or 3.7 feet above mean low water. Log or brush mattresses loaded with riprap stone should be used below low water, and stone alone above that level. Some oyster shells might be used to advantage in loading the mattresses, as they would probably promote a rapid shell growth. The cost of the improvement is estimated, in round numbers, at $197,000.

ESTIMATES.

Dredging, 55,000 cubic yards, in place, at 25 cents	$13,750.00
Mattresses, 64,000 square yards, at 75 cents	48,000.00
Stone, 28,500 cubic yards, at $3.50	99,750.00
Shells, 10,000 cubic yards, at $1	10,000.00
Total	171,500.00
Engineering and contingencies, 15 per cent	25,725.00
Aggregate	197,225.00

The survey was extended to include Front River, the upper part of Mud River to Scotts Creek, and a portion of Old Teakettle Creek, in order to develop two other possible routes, one by way of Front River, Scotts Creek, and Old Teakettle Creek, and the other by way of Front River, thence across the marsh through a dredged cut 3,400 feet long to Mud River, opposite the mouth of New Teakettle Creek.

For the improvement of the former route dredging only would be required. The cut connecting deep water in Front River with deep water at the mouth of Old Teakettle Creek should follow approximately the windings of the upper half mile of the river and of Scotts Creek, both of which would need deepening and widening. There are also two small shoals near the head of Front River and one near the mouth of Old Teakettle Creek that would require deepening. The total amount of material to be removed by dredging would be about 150,000 cubic yards in place. It is quite probable that considerable expenditures would be required for maintenance, possibly from $3,000 to $5,000 per year.

ESTIMATE.

Dredging, 150,000 cubic yards, in place, at 25 cents	$37,500
Engineering and contingencies, 15 per cent	5,625
Total	43,125
Annual expenditure and maintenance $4,000, 5 per cent interest on	80,000
Aggregate	123,125

The improvement of the second route through Front River would require the opening of a cut through 3,400 feet of marsh to a depth of 14 feet. A cut would also be necessary through the shoal in Mud River between the mouth of the marsh cut and the mouth of New Teakettle Creek. A high dam on the eastern side of this channel, closing Mud River, and a low sill dam on the western side would be necessary to direct the currents in the direction of the channel and to keep out the mud which would otherwise fill the cut under the action of the cross currents. The improvement, once completed, would probably be self-maintaining.

ESTIMATES.

Dredging, 200,000 cubic yards, in place, at 25 cents	$50,000.00
Mattresses, 42,500 square yards, at 75 cents	31,875.00
Stone, 19,000 cubic yards, at $3.50	66,500.00
Shells, 7,000 cubic yards, at $1	7,000.00
Total	155,375.00
Engineering and contingencies, 15 per cent	23,306.25
Aggregate	178,681.25

The most desirable route of all those mentioned is the one just described, since its improvement would doubtless be permanent, but the immediate outlay required for giving a channel 7 feet deep at mean low water through Mud River by dredging alone being only about $16,000, that route is recommended for improvement. When the commercial, military, or naval necessities of the country require a deeper channel than 7 feet along the inside route to Florida, the last route described will doubtless be adopted.

LITTLE MUD RIVER.

The next point to the southward having an insufficient depth of water is in Little Mud River, where a short shoal exists about 4,000 feet from

the mouth. The river widens out excessively where it joins Altamaha Sound, and the narrow channel lies close along the eastern shore with depths of from 7.2 to 9.6 feet, except at the point mentioned, while west of the channel is a broad mud flat over which the depths are from 1 foot to 3 feet. Near the mouth of the river, where the channel depth is but 7.2 feet, the 7-foot curves on either side approach each other so closely as to cause some difficulty in low-water navigation.

In the deeper portions of the channel the bottom is composed of stiff mud, mixed with clay. In the shoaler portions a softer mud is found, and on the mud flat the bottom is very soft.

The mean range of tide, as approximately determined by only a few observations, is about 6.7 feet. The tidal currents on the day they were observed moved to the south slowly at high water, and continued to do so for about four hours thereafter, when they changed to the north, soon became strong, and lasted until about two hours after low water, when they slackened and again turned to the south. There were therefore strong northerly currents for about four hours, and weak southerly currents for about eight hours out of the twelve. The observations were made, however, during a freshet in the Altamaha River, and during a strong wind from the west and southwest. The above results are therefore probably somewhat abnormal. The observed maximum velocity of the northern current was 1.4 feet per second with a bottom velocity of 1.1 feet, and that of the southerly current about 0.5 of a foot per second with a bottom velocity of 0.2 foot.

A comparison of the present survey with former ones shows that the river near its mouth is gradually narrowing, and at a point 4,000 feet from the mouth is only about one-half of its former width. The depths have at the same time increased. At the mouth of the river, where formerly a channel depth of but 4 feet was shown, there is now a depth of from 8 to 9 feet at mean low water. The only works of improvement required here are the deepening of the shoal 4,000 feet from the mouth by the removal of about 2,000 cubic yards of material and a slight widening of the channel near the river's mouth by the removal of about 1,000 cubic yards, which would cost, in all, about $1,000.

Since the channel is deepening through natural agencies, it is probable that the improved channel would be self-maintaining.

JEKYL CREEK.

Jekyl Creek connects St. Simon Sound on the north with St. Andrews Sound on the south. It is about 5 miles long and carries ample depths except near the northern end, where two shoals exist, one just outside the mouth, where the channel crosses a mud flat to reach deep water in Brunswick River, and the other about 1 mile from the mouth, where the widths are excessive and where the creek is joined by Mud River. The outer shoal is about 2,000 feet long, with an average mean low-water depth of 5.6 feet and a minimum depth of about 4.8 feet. The inner shoal is about 3,000 feet long, with an average low-water depth of 6 feet and a minimum depth of about 5.3 feet. The material composing the bottom on the outer shoal is very soft mud, and that on the inner shoal mud ranging from soft to stiff.

The mean range of tide in the creek, as determined by the limited number of observations available, is 7.1 feet. The tidal currents in the northern end of the creek are quite irregular and are largely affected by the force and direction of the wind. A stiff northerly wind will cause a southerly flow in the northern end of the creek throughout the

whole tide, but a southerly wind does not produce the opposite effect of constant northerly currents, the flood current being southerly and the ebb northerly.

Under normal conditions the current is toward the south during the entire flood and during a part of the ebb tide, and toward the north during only a part of the ebb tide. The preponderance of flow is therefore toward the south. The stormy weather that prevailed during the survey of Jekyl Creek prevented a satisfactory determination of its current velocities, but former observations show them to be sufficient, if properly controlled and directed, to maintain the required depth in the channel when once obtained.

Jekyl Creek has already received attention from the General Government, a project for its improvement having been prepared by General Gillmore, the engineer then in charge, and printed as Appendix No. 10, Annual Report of the Chief of Engineers for 1888.

It provides for—

(1) A training wall at the mouth of the creek, designed to guide and concentrate the ebb currents across the mud flats to the deep water of Brunswick River.

(2) A closing dam across Mud River, to prevent the escape of water through that estuary.

(3) Dredging across the mud flats at the entrance to Jekyl Creek and in the creek proper near the mouth of the river.

The training wall and closing dams are to be constructed of log or brush mattresses, brush fascines, and riprap stone below the level of low water; stone alone to be used above that level.

The cost of the improvement was estimated at $38,590. An appropriation of $5,000 was made for the work in 1888 and another of $7,500 in 1890. Such inadequate and infrequent appropriations increase the cost of the work and much dredging will have to be done again, because it has been impossible, with the limited amounts available, to construct the training wall and dam necessary to maintain the acquired depths. All of the first and part of the second appropriation were expended in dredging. The remainder of the second appropriation was expended in the construction of 513.5 linear feet of foundation course of the training wall across the outer shoal. To complete the work will require the expenditure of $35,000, the increase in the original estimate being made necessary by the inadequate appropriations heretofore made.

For further details in connection with the work of improving Jekyl Creek I respectfully refer to Annual Reports of the Chief of Engineers for 1888 *et seq.*

THE DIVIDINGS.

Cumberland River, branching from St. Andrews Sound, and the long arm of Cumberland Sound meet at the mouth of Crooked River. The tides from opposite directions meet there on the flood and part on the ebb, and the point is therefore known as "The Dividings." A sand spit extends from the Cumberland Island shore toward the mouth of Crooked River, causing the channel to curve in the shape of a horseshoe and giving to the point the name of Horseshoe Shoal. The length of the horseshoe-shaped portion of the channel is about 3,000 feet, and at its narrowest point the 7-foot mean low-water curves are fully 100 feet apart. The minimum channel depth is 7.3 feet and deeper water of from 8 to 10 feet is found in both directions within 200 feet of the shoalest point. The river bottom in or near the channel is composed of sand and mud, or sand and clay, and is quite firm. The shoal is composed

mostly of sand. The mean range of tide is approximately 7 feet. It was determined by the readings of one high and one low water each day from March 27 to May 1, 1891, corrected by comparison with predicted tides at Fort Clinch (Cumberland Sound) and St. Andrews Sound. The above determination errs, if at all, on the side of excess, and probably by not more than 0.2 of a foot.

A gauge was read for the same period at Cumberland wharf, giving the mean range at that point, under the same limitations, as 6.9 feet. The mean tidal range in St. Andrews Sound is 6.8 feet and at Fort Clinch 5.9 feet.

At low water ebb currents are still flowing from Crooked River strongly into Cumberland River and very feebly into Cumberland Sound. Flood currents then begin in Cumberland Sound and for nearly two hours divide and enter both Crooked River and Cumberland River, causing a northerly flow across Horseshoe Shoal. Two hours after low water slack water occurs at the head of Cumberland River, and all of the flood from Cumberland Sound enters Crooked River. During the third, fourth, and fifth hours of the flood the currents from both Cumberland Sound and Cumberland River meet at the point of the horseshoe and enter Crooked River. Ebb currents are established first in Cumberland Sound shortly after high water, and for nearly two hours a southerly flow takes place across the point of the horseshoe from Cumberland River to Cumberland Sound, and at the same time the ebb currents from Crooked River, beginning about one hour after high water, flow also to the south.

Slack water occurs at the head of Cumberland River at two hours after high water. During the third, fourth, and fifth hours of the ebb the currents from Crooked River divide at the point of the horseshoe and flow to the north in Cumberland River and to the south in Cumberland Sound.

The maximum observed flood (southerly) velocity in the channel at the head of Cumberland River, just north of the Horseshoe, was 1.2 feet per second with a bottom velocity of about 1 foot. The maximum ebb (northerly) velocity at the same point was 1.4 feet per second, with a bottom velocity of about 1.2 feet. In the deep pocket near the Cumberland Island shore the maximum flood velocity was 1.3 feet per second and the maximum ebb velocity 0.9 of a foot per second.

At the head of Cumberland River the approximate total flood flow through a section 1 foot wide and 12.2 feet deep at mean low water was nearly 350,000 cubic feet, and the total ebb flow through the same section was approximately 290,000 cubic feet, the excess of 60,000 cubic feet toward the south being due to the greater mean elevation of the water surface during the flood currents. The average depth at the point considered during flood currents was 17.5 feet, while during ebb currents it was but 14.7 feet.

In the deep pocket near Cumberland Island the total flood flow through a similar section 9 feet deep at mean low water was about 276,000 cubic feet and the total ebb flow was nearly 150,000 cubic feet, the excess there being also toward the south, and amounting to about 126,000 cubic feet. It is probable that on the day the observations were taken the flow toward the south at the head of Cumberland River exceeded that toward the north during one entire tide by more than 100,000,000 cubic feet. The observations were not extended enough, however, to determine the influence of the wind, which is probably considerable. They were made when the range of tide was normal, the direction of the wind not being reported. In the absence of more com-

plete evidence the above results are assumed to be approximately correct, although more extended observations might change them materially. Great changes have taken place in this vicinity within the last few years. The Coast Survey charts show that an island once existed in the middle of the river, opposite the mouth of Brickhill (Kiln) Creek. The island has been entirely washed away. It is said to have shown above low water not more than ten years ago, but in its place there is now a depth of from 4 to 13 feet of water. A former channel depth of 7 feet north of the Horseshoe has increased to 9.5 feet, and at the point of the shoal a former depth of 6.2 feet has increased to 8 or 9 feet.

The survey shows that there are now ample depths at that point. Should any difficulty be experienced in making the turn around Horseshoe Shoal it can be avoided by entering the mouth of Crooked River, where the 7-foot mean low-water courses are 800 feet apart, affording ample room for turning and starting into the opposite branch of the curved channel. The channel should be marked by range lights and buoys. No works of improvement are therefore recommended at The Dividings.

SUMMARY.

The survey just made discloses the fact that to establish a continuous channel not less than 7 feet deep at mean low water between Savannah, Ga., and Fernandina, Fla., will require works of improvement at four points, viz, Romerly Marsh, Mud River, Little Mud River, and Jekyl Creek. The expenditures involved are, in round numbers—

Romerly Marsh	$63,000
Mud River	96,000
Little Mud River	1,000
Jekyl Creek (completion)	35,000
Total	195,000

If the estimated cost of maintenance be not included, the above estimate becomes—

Romerly Marsh	$53,000
Mud River	16,000
Little Mud River	1,000
Jekyl Creek (completion)	35,000
Total	105,000

COMMERCE.

The inside route is of great value to the coasting trade between Savannah and Fernandina, and the intermediate points. A regular line of steamers plies the entire route, making semiweekly trips. Another line is established between Savannah and Darien, making three trips per week. A small steamer makes daily round trips between Brunswick and Darien, and on the Cumberland route a daily round-trip schedule is maintained between Brunswick and Fernandina, connecting at Brunswick with the Brunswick and Western and the East Tennessee, Virginia and Georgia railways. The above-named steamers carry passengers as well as freight. There are also a number of small freight steamers making irregular but frequent trips between the Ogeechee, Altamaha, and Satilla rivers, and the ports of Savannah, Darien, and Brunswick. Other small steamers are engaged in the oyster and fishing business, and ply between the numerous oyster beds

and fishing grounds along the inside route, and the several coast cities. A large fleet of sloops and schooners of from 25 to 50 tons burden bring oysters, fish, rice, and shells from points along the inside route to the cities, and a number of barges, towed by tugboats, are used in transporting the products of the sea and of the coast plantations to the city markets. Large vessels are often towed from port to port without cargo or ballast by the inside route, when it would be impossible for them to reach the desired port by sea without taking in ballast; and partially loaded vessels often take the inside route to another port to complete their cargoes, thus avoiding rough weather at sea. About 25,000,000 feet of lumber are annually rafted and towed from the mouth of the Altamaha River to Sapelo Sound and St. Simon Sound for shipment in deep-draft vessels to foreign ports.

It is difficult to estimate the actual amount and value of the commerce dependent upon the inside route, owing to its varied character and to the fact that much miscellaneous freight is carried by the package, its weight and value not being known. Moreover, repeated applications to the owners of some of the boats plying those waters for information concerning the traffic of their boats have elicited no response, and in such cases the amount of traffic can only be roughly estimated. The steamers of the Sea Island and the Cumberland routes and the other regular lines draw not over 6 feet of water. The tugboats engaged in rafting lumber and in towing vessels, barges, and lighters draw from 7 to 10.5 feet, and vessels under tow often have the maximum draft that can be carried through the portion of the route they traverse.

The freights carried outward from the cities along the inside route are mainly general merchandise, commercial fertilizers and guano, mill and camp supplies. The freights collected along the route and brought to the cities consist of cotton, rice, naval stores, vegetables, fruit, oysters, fish, and shells.

Commercial statistics were collected with reference to the points at which work of improvement would be necessary and an estimate, based on the most reliable sources of information available, is given in the following table:

Through.	Number of trips.	Tons of freight.	Value of freight.	Number of passengers.
Romerly Marsh	820	51,000	$1,020,000	10,000
Mud River	1,460	60,800	970,000	3,000
Little Mud River	570	28,000	325,000	4,000
Jekyl Creek	2,520	45,000	955,000	26,000
The Dividings	1,080	19,000	460,000	11,000

The above table does not include the commerce of the boats of less than 20 tons burden or the tonnage of the towboats engaged in towing vessels and lighters. Some of the commerce included in the above table passes two or more of the points under which it is grouped and is therefore counted more than once. Considering the route as a whole, the total traffic during the year ending June 30, 1891, was approximately as follows:

Number of trips	4,900
Tons of freight carried	156,000
Value of freight	$2,787,000
Number of passengers	41,000

The improvement of the shoals which now obstruct navigation on the inside route would render possible a much better passenger and freight service than is now maintained. The boats of the regular lines would then be able to run on schedule time, and not be compelled to wait for a suitable stage of tide for crossing the shoals. The boats of the Cumberland route carry the United States mails as well as passengers and freight, and are so run as to connect with the Florida Central and Peninsular Railway at Fernandina, and the Brunswick and Western, and the East Tennessee, Virginia and Georgia railways at Brunswick. Those boats are frequently delayed at Jekyl Creek, and great inconvenience and loss are caused by the consequent interruption of the schedule. There can be no doubt that the opening of a continuous channel not less than 7 feet deep at mean low water between Savannah and Fernandina would be followed by a great increase in the annual commerce of the inside route.

The importance of the route for military and naval purposes has already been mentioned in former reports. The improved channel will be available for gunboats and transports drawing from 12 to 14 feet of water, and it would particularly favor the operations of our torpedo boats against hostile vessels. Exits to the sea are afforded at intervals of from 5 to 15 miles through the numerous sounds that indent the coast, from which those boats could dash forth, strike a sudden blow, and returning, find close at hand a safe harbor secure from attack and from storms.

If the recent recommendations of the general commanding the Department of the East in regard to the defense of the South Atlantic ports by means of a strongly fortified central station, including Port Royal Harbor and Tybee Roads, be carried into effect, then the importance of the inside route as an adjunct to such defense can scarcely be overestimated, and whatever may be the plan of defense adopted for those ports the inside route will be a potent factor in its efficiency.

An effective blockade of the Southern ports by a foreign fleet would be practically impossible, because light-draft vessels could enter or leave at any of the sounds along nearly 200 miles of the coast and reach the desired seaport by the inside route.

In view of the great commercial value of this route, as well as of its military importance and of the comparatively insignificant expenditures involved as compared with the benefits to be derived therefrom, I am of the opinion that "the inside route between Savannah, Ga., and Fernandina, Fla., with a view to obtaining a steamboat channel of 7 feet depth at mean low water," is worthy of improvement.

Irregular and inadequate appropriations will greatly increase the cost of the work and delay its completion, and it is therefore recommended that unless the total sum required for its completion, viz, $105,000, can be appropriated at one time no appropriation for the work may be made.

APPENDICES.*

1. Map of "New Cut" and part of Wassaw Creek, Romerly Marsh. Scale: 1 : 1200.
2. Map of Habersham Creek and vicinity, Romerly Marsh. Scale: 1 : 1200.
3. Map of Mud River and vicinity. Scale: 1 : 4800.
4. Map of Little Mud River. Scale: 1 : 4800.
5. Map of Jekyl Creek. Scale: 1 : 4800.
6. Map of The Dividings, Cumberland River and Sound. Scale: 1 : 4800.

*Not printed.

7. Diagram of directions and velocities of currents in New Cut and Wassaw Creek, Romerly Marsh. Scale: 1 : 1200.
8. Diagram of directions and velocities of currents in Mud River. Scale: 1 : 4800.
9. Diagram of directions and velocities of currents at The Dividings. Scale: 1 : 4800.

Respectfully submitted.

O. M. CARTER,
Capt., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 30, 1891.

Respectfully submitted to the Chief of Engineers.

I concur in the recommendations of Captain Carter.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

N 13.

[Printed in House Ex. Doc. No. 34, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF BRUNSWICK OUTER BAR, GEORGIA, TO DETERMINE THE FEASIBILITY AND COST OF DEEPENING THE SAME TO 26 FEET AT ORDINARY HIGH WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., October 8, 1890.

GENERAL: In compliance with Department letter dated September 20, 1890, I have the honor to submit the following report of a preliminary examination of "Brunswick Outer Bar, Georgia, to determine the feasibility and cost of deepening the same to 26 feet at ordinary high water."

Brunswick is situated upon the east coast of Georgia, about 60 miles by the coast line south of the Savannah River. The outer harbor comprises the anchorages in Brunswick River and St. Simon Sound, and "Brunswick Outer Bar" is assumed to mean the ocean bar which obstructs the entrance to St. Simon Sound.

The earliest reliable survey of that locality known to me is one made by the United States Coast Survey between 1856 and 1860. The bar, which extends in a horseshoe shape across the entrance from St. Simon Island on the north to Jekyl Island on the south, has not changed much in location or general direction since the time of that survey. The channel across it has, however, shoaled greatly, the minimum mean low-water depth, which was 15 feet at the time of the former survey, being at the present time not more than 11½ feet. The outer 18-foot curve has not moved appreciably seaward, but the navigable bar channel has shifted its position toward the south, the 6-foot curve of the north breakers having moved southward about one-half of a mile in the last thirty years. Some slight shoaling has also taken place in the deep pocket inside of the crest of the bar, one sand spur, directly in the channel, and with a depth of water less than 18 feet at mean low tide, having moved shoreward about three-quarters of a mile. Detailed information concerning the bar can be given only after a survey of the locality has been made.

The importance of the city of Brunswick as a seaport has increased with remarkable rapidity during the past ten years. The population has increased from less than 3,000 in 1880 to about 12,000 in 1890. Taxable property has increased during the same period from $1,300,000 to $6,000,000. The naval stores business, which was first begun there in 1875, reached a value of over $1,000,000 in 1889. The annual timber shipments increased during the same period from 37,000,000 feet to over 100,000,000. Cotton shipments of 4,000 bales in 1884–'85 reached nearly 175,000 bales in 1889–'90. Between 80 and 90 per cent of the total trade

of Brunswick is dependent upon water carriage. Two railroads terminate at that point, the East Tennessee, Virginia and Georgia reaching, with its connections, the North and Northwest, and the Brunswick and Western extending into Georgia, Alabama, and beyond.

The following lines of steamers are established:

Brunswick to New York, one per week.
Brunswick to Savannah, two per week.
Brunswick to river points, fourteen per week.

Besides those a large fleet of foreign and coastwise sail and steam vessels engage in the Brunswick trade, which consists chiefly of cotton, timber, lumber, and naval stores.

The shoaling which has taken place on the bar, and which prevents vessels of large carrying capacity from entering the harbor, seriously threatens the commerce of the port and retards its further development.

I respectfully invite attention to the appended letters of the mayor of the city and the president of the Board of Trade, and of the president of the Brunswick Terminal Company.

For all the reasons stated I am of the opinion that the harbor is worthy of improvement. The estimated cost of a survey on which to base a plan and estimate of improvement is $6,000.

It is imperative that the calm weather usually prevailing at this season of the year be taken advantage of, lest the estimated cost be greatly exceeded and the completion of the survey much delayed. The survey should be begun at once.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[Second indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., November 20, 1890.

Respectfully returned to the Chief of Engineers. In view of the facts and reasons set forth in the report of the local engineer it is considered that the locality is worthy of improvement.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

LETTER FROM THE MAYOR OF THE CITY OF BRUNSWICK AND THE PRESIDENT OF THE BOARD OF TRADE.

BRUNSWICK, GA., *October 7, 1890.*

DEAR SIR: In answer to your inquiry as to the commercial reasons in favor of the deepening of the outer bar of Brunswick, we have to say that the wonderful progress of Brunswick from 1880 to 1890 from a population of 2,981 in 1880, to a population of over 12,000 for 1890; the increase in the lumber business from 37,000,000 feet in 1875, to over 100,000,000 feet; the increase in the cotton business from 4,000 bales for the season of 1884-'85, to 162,930 bales for the season of 1889-'90; the increase in naval stores from nothing in 1874 to over $1,000,000 for the season of 1889; the creation within the past three years of a new business rapidly growing in importance in the shipment of cross-ties from this port, which loads vessels to their dead-weight capacity, indicate the importance of deepening the outer bar for the reason that the draft of vessels recently constructed and in course of construction is much greater than at any time prior to 1885, and for the reason that charterers can obtain deeper-

draft vessels at a much lower rate per ton than the lighter-draft vessels, and having a wider range for charters if enabled to charter deep-draft as well as light-draft vessels, are enabled to procure at all times better charter parties and better rates of freight.

The East Tennessee, Virginia and Georgia Railroad Company has its ocean terminus at Brunswick, and touches every important commercial city in the interior, whether with its main line and branches or with connections made by traffic contract.

The Brunswick and Western Railroad Company, a part of the Plant system of railroads, through the Alabama Midland Railroad, constructed from Bainbridge to Montgomery, and rapidly being extended from Montgomery to Tuscaloosa, and these with the Illinois Central gives us another important line of western and northwestern connections. Both these railroad systems traverse the great iron and coal belt of the South, and reach into and connect with the great northwestern systems traversing the grain section of the West and Northwest, and also connect with the southwestern system of railroads.

The East Tennessee, Virginia and Georgia Railroad Company's terminal at Brunswick is upon 22 feet of water at its wharves at ordinary low water, and there is in the channel of Turtle River for its whole distance to the sea more than 22 feet which can be carried to the bar, at which point but 11¼ feet at ordinary mean low water is shown by the last United States Coast Survey chart. While it is probable that by the changes which have occurred in the location of the channel deeper water can at times be obtained over the bar, yet the railroads terminating at this point, the people interested in its commerce and the people in the territory tributary to Brunswick are compelled to seek other ports at a greater expense than they would be put to if this obstruction was removed.

Another view of this matter which our Board desires to present for your consideration is that Brunswick is in the extreme curvature of the South Atlantic coast; it is nearer than any other South Atlantic port to all interior points in the South, in the West, in the Northwest.

We desire to present for your consideration the fact that our harbor by the formation of the islands of St. Simon and Jekyl is absolutely landlocked; and that, as can be seen by a mere glance at the Coast Survey chart of our harbor, the arms of the sea which create it give us 37 miles of water front easily and cheaply available with deep water close in shore. The wonderful growth of the South for the past ten years, the tremendous investments in productive industries of various character, have vastly increased the freight product which must find outlets to the markets of the world. The vast amount of money invested in the past four years in productive industries of the South—in 1888, $161,000,000; in 1889, $229,000,000—must increase still further the enormous freight product shown by the figures of 1889 and 1890, thus indicating the national importance of an improvement of this character as creating an additional outlet for the vast products of the interior of the South, as well as an additional outlet for the vast products of the Northwest and West which during the winter months cannot find adequate outlet over the great trunk lines of the North by reason of blockades of ice and snow, and can find outlet over lines never thus obstructed, with easy grades to this port by shorter lines of haul, an advantage not only applicable to the grain and flour of that section, but also applicable to the increasing export of cattle.

There has been, within the last three years, invested in Brunswick, of northern capital $3,250,000, and if the outer bar was deepened to 26 feet at mean high water there would be a certainty of future investments in terminal facilities and commercial business of various kinds of a magnitude commensurate with the enlarged business which would be at once created at this point.

Respectfully submitted.

C. DOWNING,
President Board of Trade.
J. J. SPEARS,
Mayor City of Brunswick, Ga.

Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

LETTER OF MR. A. F. CHURCHILL, PRESIDENT AND GENERAL MANAGER OF THE BRUNSWICK TERMINAL COMPANY.

BRUNSWICK, GA., *October 7, 1890.*

DEAR SIR: This company is laboring under a great disadvantage in chartering vessels, owing to the shoal water on the bar.

Our neighboring ports that have more water on the bar than we have on ours can get cheaper ships than we can. I was offered a ship to-day at 75 cents per register ton less than I am compelled to pay for suitable draft vessels for this port.

This means prohibition for the exports to the port of Brunswick, and compels all interior markets naturally tributary to the port of Brunswick to ship their goods to other ports, not only at an increased cost to them, but at a loss of the business to Brunswick.

You can readily see the disadvantage under which we are laboring; can not the remedy be applied, and put the port of Brunswick on equal footing, equal rates, and equal draft of water on the bar with our neighboring ports?

Yours, very truly,

A. F. CHURCHILL,
President and General Manager.

Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

SURVEY OF BRUNSWICK OUTER BAR, GEORGIA, TO DETERMINE THE FEASIBILITY AND COST OF DEEPENING THE SAME TO 26 FEET AT ORDINARY HIGH WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., December 10, 1891.

GENERAL: In accordance with the requirements of section 17 of the river and harbor act of September 19, 1890, and instructions from the Chief of Engineers, dated November 21, 1890, I have the honor to submit herewith my report upon the survey of "Brunswick Outer Bar, Georgia, to determine the feasibility and cost of deepening the same to 26 feet at ordinary high water," together with a project for its improvement and an estimate of the cost of the same.

A brief description of the aim of the proposed improvement and some facts relating to its commercial importance are given in my report upon the preliminary examination, dated October 8, 1890, to which I respectfully refer.

The survey of the bar was made under my direction by my assistant, Lieut. Thomas H. Rees, Corps of Engineers, U. S. Army, between December, 1890, and June, 1891. His very complete report, submitted this date, renders unnecessary any further discussion of the subject, and is transmitted herewith as a part of my report.

The project of improvement, proposed therein was prepared under my direction, and is approved.

The estimated cost of the improvement which, in round numbers, is $2,700,000, supposes that money is regularly and adequately supplied. Without this the cost of the work will be largely increased and its success rendered doubtful.

That advantage may be taken of experience gained in the work, wide discretion should be allowed the engineer in charge, especially as to the form of the jetty cross section and the order in which work is to be done.

Respectfully submitted.

O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUT. THOMAS H. REES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., December 10, 1891.

CAPTAIN: I have the honor to submit herewith my report on a survey of Brunswick Outer Bar, made pursuant to your orders of December 8, 1890, together with a project for its improvement, with a view of obtaining a channel 26 feet in depth at mean high water, and an estimate of the cost thereof.

I will first describe the methods and results of the survey, and then give a general description of the harbor and its commerce, and the plan proposed for its improvement. Your orders of December 8, 1890, and verbal instructions of the same date, directed a complete hydrographic survey of Brunswick Outer Bar and the adjacent channels and shoals, to include—

(1) A triangulation covering the shore area within the limits of the survey.

(2) The topography of the shores within the same limits.

(3) The determination of azimuths by observations on a circumpolar star, and of magnetic declination by compass readings.

(4) Soundings thoroughly covering the bar and adjacent channels and shoals between the shore and the outer 24-foot mean low-water curve.

(5) Tidal observations at the following points, viz, at Ocean Pier, at some point on Brunswick River, at the city of Brunswick, and at the East Tennessee, Virginia and Georgia Railroad wharf on Turtle River.

(6) Current observations for velocities and directions at necessary points.

(7) Determination of the character of the bottom.

(8) The plotting of maps and diagrams showing the results of the survey.

The necessary instruments and boats were obtained from your office, and the steam launch, with a complete outfit for the survey, reached Brunswick December 16.

A party, consisting of 1 assistant engineer, 2 surveyors, 1 rodman, 1 recorder, 1 master of launch, 1 engineer, 1 leadsman, 1 cook, 1 or more boatmen and laborers, as needed, was assembled and quartered on St. Simon Island, and active operations were begun on the 19th.

BASE LINE.

A suitable location for a base line was found across the southern end of St. Simon Island. The line was cleared of trees and brush, and stout, square stakes were driven exactly on line and a little less than 100 feet apart. A square of tin, marked with a fine-lined cross (+) was tacked to the top of each stake. A 100-foot steel tape was used in the measurements. A number of narrow open boxes, from 15 to 20 feet long and 5 inches high, was prepared, their aggregate length being a little less than 100 feet. These were blocked up end to end in a straight line between two of the stakes, the extreme ends being exactly even with the tins on the tops of the latter. The tape was stretched in the line of boxes and left there with a Fahrenheit thermometer until a uniform temperature should be attained. The front end of the tape was then held rigidly at some even division and the tape stretched by a 12-pound pull at the rear end, applied by a spring balance, and this end of the tape was read to the nearest one-thousandth of a foot. The temperature was recorded at the same time. The tape was thus protected from the wind and from the direct rays of the sun; it was maintained in a straight line without sag, and its temperature was closely determined. Each reading was taken twice to avoid errors, and the whole line was measured twice. No attempt was made to keep the tape horizontal during a measurement, but the difference in elevation of the stakes was found by leveling and the measured distance reduced to the horizontal distance.

The form of record was as follows:

Base line, December 23, 1890.

[Observers: Rees, Paret.]

Station.	Rear end.	Front end.	Difference in elevation of stakes.	Horizontal length.	Temperature, F.
	′	′	′	′	°
0 to 1	0.225	99.4	0.54	99.1734	64
1 to 2	0.295	99.4	0.69	99.1025	61
(*)	(*)	(*)	(*)	(*)	(*)
44 to 45	0.324	44.6	2.71	44.1930	66
Measured length				3,984.7431	

The coefficient of expansion of the steel tape used for 1 foot and 1° F. is 0.00000692, and the tape is standard length at 46.6° F. The mean temperature during this measurement was 64.6°, hence 46.6 — 64.6 equals (—) 18.0°, and,

	Feet.
(—) 18 × 3984.74 × .00000692 = ...	(—) 0.4963
Measured length = ...	3,984.7431
Corrected length = ...	3,984.2468
The second measurement gave the following corrected result	3,984.2822
And a consequent mean of	3,984.2645

With a probable error of 1 unit in about 225,000. The standard referred to is that of the Mississippi River Commission. At each end of the base an iron rod about 5 feet long was sunk flush with the surface of the ground, and over them the triangulation stations were erected.

TRIANGULATION.

Besides the stations at east base and west base, five others were established. The tower of the Hotel St. Simon served admirably as one station. The light-house tower gave another. An unused beacon on the mainland, opposite the entrance, was used as a station, and two other stations were erected on Jeykl Island at its northern point, and at a point about 2 miles down the beach. This southernmost point and hotel are 6,890.8 yards apart, and afforded an excellent base line for the location of offshore soundings. They were, in fact, selected with that object in view. The seven stations were connected by a system of five triangles, the angles of which were measured by the method of repetitions. From eleven to thirty readings of each angle were taken. The errors of closure of the triangles were

$$+04.0'', -01.7'', +08.2'', +03.9'', \text{ and } +16.4''.$$

This last error occurred in a large ill-shaped triangle, one station of which was very indistinct and difficult to read accurately. The theodolite used in triangulation read only to 20 seconds of arc; therefore, the above errors are as small as could be expected. The light-house could not be occupied centrally by the instrument, and the angles were therefore measured at an eccentric point and reduced to the center by the formula

$$C = O + \frac{\sin(O+y)}{D \sin 1''} - \frac{r \sin y}{G \sin 1''},$$

in which C is the required angle and O is the measured angle.

None of the triangles used were very fair-shaped, but better ones could not be obtained without using several additional points and erecting stations from 30 to 50 feet high, which the requirements of the survey did not warrant.

TOPOGRAPHY.

The topography of the shore line, including high and low water lines, and the principal features in the vicinity of the shore, were obtained by running stadia lines, beginning at and closing on triangulation stations. This work was mostly performed in January, but it was subsequently found that several storm tides had materially altered the conformation of the shore line; and in order to determine the extent of this alteration, high and low water lines were again located in May, and the different positions of these lines are shown on the final map of the survey. There were in all about 12 miles of stadia lines run, and 113 stations occupied. There were also 14 cross sections of the beach taken.

AZIMUTH.

The line, the astronomical azimuth of which was determined, was east base, hotel. It happened that a time could be selected for the observations, when Polaris reached western elongation just after sunset, so that while Polaris was visible, there was still sufficient light to see the cross hairs and the mark at station "hotel" without illuminating either. The terrestrial mark, the point of a lightning rod at the apex of the hotel tower, was therefore the same as that observed in triangulation, and its size and distance were such that it was not found necessary to change the focus

of the instrument after observing the star. An excellent set of observations was thus obtained, giving the azimuth of the line east base, hotel, measured from the south point round by the west equal to 230° 55′ 04″.

In this connection it may be stated that the same station (east base) and mark (hotel) were used in taking observations for magnetic declination. After a large number of observations for this purpose had been taken with Brandis Transit, No. 1054, it was found that the readings did not agree at all well, and investigation showed that the needle was so sluggish that it could not be set accurately, a change of several minutes of arc occurring after a disturbance of the needle. The Gurley Transit was therefore used, after thorough adjustment, in a new series of observations, and the result showed that it was much better suited to the purpose than the Brandis instrument. The mean of thirteen sets of observations, each set containing five readings, gave the magnetic azimuth of the line east base, hotel, measured from

	°	′	″
the south point round by the west=	229	25	27
True azimuth, as above=	230	55	04
Hence magnetic declination, east=	1	29	37

SOUNDINGS.

All soundings were taken from the steam launch. An 8-pound lead was used in depths not exceeding 40 feet, and a 12-pound one in greater depths. The lead line was kept constantly wet and was compared before and after each day's work, with the steel tape. The pull exerted on the lead line during sounding, at the speed usually maintained, was found, with a spring balance, to be about 12 pounds; and this same pull was always applied in stretching the line during comparisons with the tape. The soundings were located at one-minute intervals by angles from two transits at triangulation stations on shore, selected with reference to giving good angles of intersection over the area to be sounded. This gave from two to six intermediate soundings to be placed by equal spacing between the located points. A chronometer was used on the launch for keeping time, and the watches of the transitmen were compared with the chronometer before and after each day's work. The sounding to be located was indicated to the transitman by a signal on the launch given at the instant the lead line became vertical on the sounding nearest the end of the even minute. The signal used was cylindrical in form, about 18 inches in diameter and 3 feet high, arranged to slide centrally on a vertical pole and to collapse like a bellows when dropped. It was raised and dropped by means of halyards.

Two sets of lines of soundings were run, one set running off and on shore approximately perpendicular to the shore line, and the other set crossing the first nearly at right angles. The offshore soundings were so distant as to render it impossible to see ordinary shore ranges; therefore, in order to cover the ground uniformly, the following method was adopted: The light-house tower on St. Simon Island was used as a signal station, and the offshore lines of the first set radiated from this point. The lines were established by the setting of a transit located on the light-house tower, and the launch was kept as nearly as possible on the cross hairs of the instrument by the motions of a large signal flag. When the flag was displayed on the north side of the tower the launch would incline gradually in that direction; as she approached the proper line, the flag would be raised to a vertical position and the launch would be straightened out on her course. The opposite motion of the flag moved the launch to the southward and she could thus be kept within a few feet of the true line.

The inshore lines of the first set were run on ranges established on shore from 400 to 500 feet apart. The lines of the second set, crossing the first, were run from an anchored range boat carrying a large flag, which was always kept by the launch in range with the most distant headland visible. After each line was completed, the range boat was moved 400 feet seaward, which spaced the lines at that interval. The headland used as the rear range point was so distant that the divergence of the lines was scarcely perceptible. The total number of soundings plotted was 36,095 and the number of located soundings was 8,176. There were in addition to these 1,062 soundings and 251 locations that were missed by one or both transits on account of rain, fog, or haze. The outer soundings were so distant that only on an exceptionally clear day could the transitman see the launch or her signals, and, under the most favorable circumstances, she was invisible to the naked eye more than half the time.

TIDAL OBSERVATIONS.

Tide gauges were established at Ocean Pier, St. Simon Island; at Quarantine Wharf, Brunswick River; at the Brunswick and Western Railway wharf, city of

Brunswick; and at the East Tennessee, Virginia and Georgia Railway wharf, on Turtle River.

At the Ocean Pier a Stierle self-registering gauge was established December 20, 1890, and maintained till June 3, 1891, giving a record of the times and heights of 297 high and low waters. A similar self-registering gauge was established at the Brunswick and Western Railway wharf, Brunswick, on January 5, 1891, and maintained until May 12, 1891, giving a record of the times and heights of 166 high waters and 152 low waters. This gauge did not work satisfactorily until some necessary alterations and repairs were effected, and a portion of the record during the above period was therefore lost. At the Quarantine wharf, Brunswick River, a staff gauge was read day and night from March 6 to April 25, 1891. The times and heights of 97 high waters and 97 low waters were recorded. At the East Tennessee, Virginia and Georgia Railway wharf, on Turtle River, day readings of high and low water on a staff gauge were begun March 19; night readings were begun April 8, and both were continued until May 19. 1891. There were recorded during this period the times and heights of 102 high waters and of 98 low waters.

LEVELING.

Bench marks were established near all gauges and connected by lines of levels, and the elevation of each bench mark with reference to mean low-water level on the adjacent gauge was determined. The distance across the Sound from St. Simon Island to the mainland is so great that level readings over the whole distance would have been unreliable, owing to the effect of refraction. Two pile stations were therefore constructed on shoals in the sound, dividing the distance into three equal parts of about 2,300 feet each. This gave level sights in opposite directions over equal spaces of water, and eliminated to a great extent the effects of curvature and refraction. In leveling across the marshes from St. Simon Sound to Brunswick and from Brunswick to the Quarantine gauge it was necessary to construct a station at each instrument point on account of the yielding and tremulous nature of the marsh soil. Stout scantlings, about 8 feet long, were sunk into the marsh until their tops were a few inches above the surface. Three of these at each station served as points of support for the tripod of the level, and one was placed at each turning point to support the level rod. The length of sight was uniformly 600 feet, measured by chaining. The line across the sound on the pile stations was leveled three times; that from the sound to Brunswick, twice; from Brunswick to the East Tennessee, Virginia and Georgia Railroad wharf, four times, and from Brunswick to Quarantine, three times. A single run over these lines covered a distance of about 12 miles, and the aggregate length of all the lines run was about 32 miles.

CURRENT OBSERVATIONS.

Current meters and submerged floats were both used in the determination of the velocities and directions of tidal currents. The meters having been repaired since previous ratings, it was necessary to rerate them, and an excellent place for this purpose was found in a small artifical pond near the city of Brunswick, filled with salt water from the sound by means of flood gates. It is 280 feet long, 100 feet wide, and from 4 to 6 feet deep. The banks are low, level, and free from brush and trees. A base line 200 feet long was laid off at one side and parallel ranges established at its ends. A large bateau was carried to the pond and fitted up in such a manner that 2 meters could be rated at the same time. A piece of scantling was lashed across the bow of the boat and its ends pierced by vertical holes 2.5 feet outboard. Iron rods passing through these holes, and held by washers, carried the meters at their lower ends at a depth of about 1.5 feet from the surface. The meters turned freely on the rods, and were connected in the usual manner with the batteries and electric registers in the boat. The boat was connected by long bow and stern lines with reels at the ends of the pond, by means of which she was hauled forth and back. The record was kept only during the forward trip. A uniform predetermined velocity was acquired before the boat reached the first cut-off range. When this range was crossed the registers were started and the chronometer read to the nearest half second. When the second range was reached the registers were stopped and the chronometer again read. During the return trip the meters and connections were examined and the registers read and adjusted, if necessary. The velocities during the trials ranged between 0.6 of a foot and 7.6 feet per second. Uniform velocities during the several runs were maintained by timing the revolutions of the reel. In this manner 4 meters were rated, viz, 2 of Buff & Berger's Ellis meters, marked respectively "A" and "B," and 2 Stackpole propeller meters, marked respectively "1" and "2." They were taken in various combinations of two in order to cross-check the results. Their

constants were determined graphically by plotting the individual results, and analytically by means of the equations,

$$a=\frac{\Sigma (x-x_0)(y-y_0)}{\Sigma (x-x_0)^2},$$

and

$b=y_0-x_0\,a$, in which a and b are the constants in the equation;
$y=ax+b$;
$x=$ revolutions per second;
$y=$ velocity in feet per second.

The resulting values of the constants are shown in the following table:

Meter.	Number of runs.	Value of A.	Value of b.
Ellis A	47	3.399	0.102
Ellis B	55	3.539	0.081
Stackpole, No. 1	36	1.719	0.193
Stackpole, No. 2	29	2.312	0.079

The floats used in addition to the meters in determining velocities and directions of currents were submerged floats made of open tin cans about 6 inches in diameter and 8 inches high, connected by a cord with a surface float of cork, 4 inches square and 1 inch thick, carrying a little staff and flag, to render it visible to a transit instrument on shore. An attempt was made to gauge the tidal flow through the gorge at the entrance to the sound by using the meters, but the great depth of the water and strength of the currents made it impossible, with the appliances available, to get any satisfactory results. The depths at the points occupied were over 80 feet at mean low water, and the bottom was soft and shifting. The difficulties encountered were dragging of anchors, sagging of the stand lines, and imperfect insulation of the lead wires, which became apparent when great lengths were required. Submerged floats run at mid depth were therefore substituted for the meters in the deep water of the entrance, and they were also used at other points when it was too rough for meter work. This work was done during the month of May, and there were but thirteen days on which observations could be made, owing to the winds and heavy seas that prevailed during that period. There were in all thirteen different positions occupied, as follows: Three on the cross section at the entrance, two in the flood channel near St. Simon Island, one near the northerly slough channel, and two in the southerly slough channel about half way between the shore and the bar; two at the bar, and three in deep water outside of the bar. Entire tides could not be observed at all points, owing to interruptions of the work by bad weather. The ebb observations are fairly complete, the flood observations only partial.

RESULTS.

The principal results rendered by the tidal observations and leveling have been platted so as to show, for each point at which observations were made—

I. Curves of semimenstrual inequality of times of high and low water.
II. Curves of semimenstrual inequality of heights of high and low water.
III. Mean tidal curves.
IV. Lines of high and low water.
V. Mean ebb and flood surface slopes.

In diagrams III, IV, and V all heights are referred to the level of mean low water at Ocean Pier. At Ocean Pier the record of tides extended over a period of about five months, and the results are therefore close approximations to the true values. At the Brunswick and Western Railway wharf, Brunswick, the partial four months' record was combined with a two months' record of the survey of Brunswick Harbor in 1889. The results of the two periods agree fairly well, and the combined means are probably quite accurate. At the other points, Quarantine and the East Tennessee, Virginia and Georgia Railway wharf, only two months' records are available, and the results must therefore be considered as only approximately correct. The correctness of the Quarantine records is especially doubtful, owing to the difficulty experienced in securing a reliable gauge reader. These records give the average time of low water here as four minutes later than low water at Brunswick, 3 miles above, which is obviously impossible. These two points are so near each other, however, that the times of low water are probably only a few minutes apart, and an

error of four or five minutes is not too much to expect from so short a period of not too reliable observations. Moreover, the duration of stand of the tides at Quarantine is exceptionally long, varying from fifteen minutes to sixty minutes, which renders it difficult to determine the exact times to assign to both low and high waters. With respect to the heights of high and low waters the results are more satisfactory, and when referred to the level of mean low water at Ocean Pier show a uniform increase in the heights of high water and a uniform decrease in the heights of low water, and a consequent uniform increase in the tidal range at the rate of about 0.1 of a foot per mile from Ocean Pier. The mean tidal curves at Ocean Pier and at Brunswick were obtained by combining a large number of curves of actual tides taken directly from the sheets of the self-registering gauges. The curves were taken at random and their number was increased until the means of their high and low water heights and times were equal to the means derived from the entire number of observations available; the resulting mean curves are therefore correct at these two points of each at least, and are probably very nearly so throughout. The mean tidal curves at Quarantine and at the East Tennessee, Virginia and Georgia Railway wharf were sketched in through the plotted positions of mean high and low water, and were made to conform as closely as possible with the known conditions governing them. From the mean tidal curves the mean ebb and flood surface slopes were derived and plotted for each hour after the generating lunar transit, as well as for the times of high and low water at Ocean Pier and the East Tennessee, Virginia and Georgia Railway wharf. From this diagram the following chronology of tidal incidents may be derived:

Hours after moon's transit.	Tidal conditions.
h. m.	
1 32	Low water at Ocean Pier. A flood slope has been established as far as Brunswick, above which point an ebb slope still exists.
2 00	Low water at East Tennessee, Virginia and Georgia Railway wharf. The flood slope has become general, but is still very flat above Brunswick.
3 00	Flood slopes throughout.
4 00	
5 00	
and	
6 00	
7 00	An ebb slope has been established as far as Quarantine, above which point the flood slope still exists.
7 34	High water at Ocean Pier. The ebb slope has reached Brunswick, above which a slight flood slope still exists.
8 19	High water at East Tennessee, Virginia and Georgia Railway wharf. Ebb slope throughout.
9 00	Ebb slopes throughout.
10 00	
11 00	
12 00	
and	
13 00	
13 57 = 1h 32m after the succeeding transit. Low water at Ocean Pier. The above succession of changes is resumed.	

The principal results derived from the tidal observations and the leveling are shown in the following table:

	Ocean pier.	Quarantine.	Brunswick and Western R. R. wharf.	East Tennessee, Virginia and Georgia R. R. wharf.
	Feet.	*Feet.*	*Feet.*	*Feet.*
Height of mean low water on gauge	0.11	0.85	(—) 0.04	0.34
Height of mean high water on gauge	6.75	8.08	7.50	8.05
Mean rise and fall	6.64	7.23	7.54	7.71
	h. m.	*h. m.*	*h. m.*	*h. m.*
High water, luni-tidal interval	7 34	7 55	8 13	8 19
Low water, luni-tidal interval	13 57½	14 17	14 13	14 28
Mean duration of fall	6 23½	6 22	6 00	6 09
Mean duration of rise	6 01½	6 03	6 25	6 16
	Feet.	*Feet.*	*Feet.*	*Feet.*
Low water of ordinary neap tides	0.75	2.00	0.68	1.00
High water of ordinary neap tides	6.10	7.95	6.85	7.25
Range of ordinary neap tides	5.35	5.95	6.17	6.25
Low water of ordinary spring tides	(-) 0.60	0.15	(—) 0.65	(—) 0.35
High water of ordinary spring tides	7.33	8.88	8.06	8.73
Range of ordinary spring tides	7.93	8.73	8.71	9.08
Highest high water observed	8.70	9.80	9.50	10.10
Lowest low water observed	(—) 2.04	(—) 1.50	(—) 2.38	(—) 2.00
Maximum range	10.74	11.30	11.88	12.10
Lowest high water observed	4.80	6.40	5.38	6.70
Highest low water observed	1.97	2.60	1.86	1.85
Minimum range	2.83	3.80	3.52	4.85
Elevation of mean low water referred to mean low water at Ocean Pier	0.00	(—) 0.15	(—) 0.30	(—) 0.36
Elevation of mean high water referred to mean low water at Ocean Pier	6.64	7.08	7.24	7.35
Increase in tidal range	0.00	0.59	0.90	1.07
Increase in tidal range per mile from Ocean Pier	0.00	0.107	0.106	0.091
Distance from Ocean Pier	0.00	29,000	44,840	61,740
	Minutes.	*Minutes.*	*Minutes.*	*Minutes.*
Time of low water after low water at Ocean Pier	0.00	19½	15½	30½
Time of high water after high water at Ocean Pier	0.00	21	39	45
Rate of propagation of low water	2,024 feet per minute.			
Rate of propagation of high water	1,372 feet per minute.			
	Feet.	*Feet.*	*Feet.*	*Feet.*
Bench mark above local mean low water	17.400	11.637	18.511	10.202
Bench mark above mean low water, Ocean Pier	17.400	11.481	18.211	9.842
Period of observations	Dec. 20 to June 3.	Mar. 6 to Apr. 25.	Jan. 5 to Mar. 12.	Mar. 19 to May 19.

CURRENT MEASUREMENTS.

The volume of ebb flow was roughly gauged on a cross-section at the entrance to St. Simon Sound by the use of submerged floats in the deep portion and by current meters in the shallow portion. The conditions of flow are so different in these two portions of the cross section that they have been treated separately and the mean velocity and discharge computed for each.

The deep portion is 2,800 feet wide and has a maximum depth at mean low water of 87 feet and a mean depth of 58.8 feet. The mean elevation of the surface above mean low water during ebb flow is 2.53 feet, and the mean cross-sectional area is 175,800 square feet. A maximum mid-depth velocity of 3.9 feet per second was observed at a point of the section 1,600 feet from St. Simon Island three hours forty-four minutes after high water. This corresponds to a maximum velocity of 4.4 feet per second under mean conditions of tidal range, assuming that the velocities for different tides are proportional to the ranges.

Reducing the observed velocities to mean conditions, there results a mean ebb velocity for the entire section of 2.044 feet per second, and a consequent mean discharge of 369,347 cubic feet per second. The mean duration of ebb flow is six hours and six minutes, and the total discharge during this period is, in round numbers, 8,111,000,000 cubic feet.

On the shoals between the deep channel and Jekyl Island the section is 4,100 feet wide and does not exceed 3.0 feet in depth at mean low water, with a mean depth of 2.0 feet. The cross-sectional area for mean elevation of surface during ebb flow is 18,348 square feet and the mean velocity for the entire section is 1.4 feet per second, which renders a discharge of 25,640 cubic feet per second and a total discharge during the six hours and twenty-three minutes of ebb flow of 589,000,000 cubic feet. The aggregate discharge is therefore about 8,700,000,000 cubic feet. Unfortunately, this re-

sult, which is only approximate, can not be checked by computing the volume of the tidal prism contained between the water surfaces that exist at the times of beginning and ending of ebb flow at the entrance, because the area of the tidal basin is unknown. There are no maps available that include the upper portions of Turtle River and its branches, and it is doubtful whether any accurate surveys of these upper streams have ever been made. A partial check may be applied by comparing the discharge of Brunswick River just below the mouth of East River, as determined by gaugings during the survey of Brunswick Harbor in 1889, increased by the volume of the tidal prism included between that section and the entrance section, with the discharge at the latter section. In computing the volume of the tidal prism it has been divided into six portions. The first includes St. Simon Sound, and the lower portions of Brunswick River and of Frederica, Back, and Mackays rivers. Its height is determined by the mean readings of the Ocean Pier gauge at the times of beginning and ending of ebb flow at the entrance. The second is the upper part of Brunswick River to the cross section gauged in 1889. Its height is determined by the gauge at Quarantine. The third includes the upper portions of Frederica, Back, and Mackays rivers to an assumed point of division between the tides of St. Simon Sound and Altamaha Sound. Its height is derived from the tidal range at Frederica as given by the U. S. Coast and Geodetic Survey. The volume included between high and low water lines, the volumes voided by the small branches and creeks, and the overflow of the marshes at high water constitute the other three portions of the prism. The last two are very uncertain, and have been simply estimated as closely as possible. The salt marshes have an area of from 20 to 25 square miles, and are partially overflowed at high water to a depth, of from 5 to 10 inches. Supposing the entire marsh area, of say 20 square miles, to be covered to an average depth of 6 inches, there would result a volume of over 275,000,000 cubic feet; 250,000,000 has been assumed as a fair estimate. The numerous small branches and creeks that wind through the marshes will probably render a volume of about 150,000,000 cubic feet. The mean ebb discharge at the Brunswick River section was found in 1889 to be approximately 3,410,000,000 cubic feet. We have, therefore, as an approximate estimate the following quantities to consider:

Tidal prism.	Area.	Height.	Volume.
	Square feet.	*Feet.*	*Cubic feet.*
St. Simon Sound	223,027,000	6.5	1,450,000,000
Brunswick River	167,270,000	7.0	1,171,000,000
Frederica, Back, and Mackays rivers	209,088,000	7.0	1,464,000,000
Between high and low water lines			72,000,000
Small branches, estimated			150,000,000
Overflowed marsh, estimated			250,000,000
Total			4,507,000,000
Discharge at Brunswick River section			3,410,000,000
Total			7,917,000,000
Compare with discharge at entrance			8,700,000,000

There is thus shown to be an excess in the gauged discharge at the entrance over the computed discharge of nearly 6 per cent.; and it may be added that the computed volume of the tidal prism has not been corrected for the flood flow that continues at the upper section a few minutes after the beginning of the ebb at the lower, or for the ebb flow that continues at the upper section a few minutes after the cessation of the same at the lower. This correction would be comparatively small, but it would slightly increase the discrepancy shown above, which must therefore be attributed to inaccuracies in the observations and insufficiency in the data used in computing the volume of the tidal prism. All that can be stated with certainty is, that the total ebb discharge at the entrance is in the neighborhood of 8,500,000,000 cubic feet, with a mean ebb velocity in the deep water of about 2.0 feet per second, and on the shoals of about 1.4 feet per second. There is ordinarily but little fresh water that finds its way to the sea through the entrance to St. Simon Sound, and the volume of flood inflow is therefore about the same as that of the ebb discharge. The mean elevation of the surface during flood is, however, 1.2 feet higher than during ebb, which slightly increases the cross sectional area and diminishes proportionally the mean velocity. The duration of flood flow is also fifteen minutes longer than that of ebb flow, which further decreases the mean flood velocities to 1.98 feet per second for the deep portion of the cross section and to 1.16 feet per second for the shoal portion. It has been reported that during very high freshets in

the Altamaha River, a considerable volume of fresh water finds its way across the low lands to the upper Turtle River and thence reaches the sea through the St. Simon entrance. Furthermore, during the freshet of February and March, 1891, some of the Altamaha discharge took place through Frederica, Mackays, and Back rivers into St. Simon Sound and the sea, as was shown by the reddish color of the water that often extended several miles into the sea at low water. There is, therefore, at times some fresh-water discharge at the St. Simon entrance, but owing to its infrequency and comparatively small amount, it can have no appreciable effect on the mean condition of tidal flow, nor on the formation of the shoals and bar.

The results of the current observations in the outer main channel, in the lateral slough and flood channels, on the bar, and in deep water beyond the bar are shown on the map of this survey by means of arrow-pointed lines, the directions and lengths of which represent respectively the directions and velocities of the currents at each hour after slack water at the point considered. Velocities are shown on a scale of 1 inch equal to 1 foot per second. These lines show that a large volume of the ebb flow is diverted toward the north through the flood channel close to St. Simon Island, and that farther from shore and just inside the bar the greatest diversion of the currents is toward south through a slough channel, the capacity of which is nearly equal to that of the main channel across the bar. They show also that the ebb currents in deep water beyond the bar have a decided southerly tendency even when the wind is in the southeast, as it was when observations were made at position No. 4. Flood current directions in this region, on the contrary, have no northerly tendency, but follow closely the direction of the main channel, and even show a slight inclination to the south. It seems probable, therefore, that there is an offshore littoral current having a southerly direction along the coast, and this conclusion is strengthened by the fact that pieces of wreckage that were barely awash, and on which therefore the wind could have little effect, have drifted from Doboy Sound south to St. Simon Sound on several occasions.

An examination of the outer channels to the sea, from the sounds along the coast in this vicinity, shows that they are all deflected toward the south, which circumstance is a farther indication of the existence of an offshore southerly current.

CHARACTER OF BOTTOM MATERIAL.

Samples of the bottom were obtained at various points and their constituents were found to be as follows: In the deep water of the entrance, opposite the Ocean Pier, the bottom in midchannel is composed of about 50 per cent of coarse white sand, 40 per cent of coarsely broken shell, and 10 per cent of fine gravel. At the northern side of the channel there were found about 90 per cent of grayish medium sand and small quantities of blue mud and fine shell. On the southern side there were found about 50 per cent of coarse white sand, 50 per cent of broken shell, and traces of fine gravel and coarse shell. On the bar proper the bottom is composed of about 70 per cent of fine grayish sand and 30 per cent of broken shell. There is a layer of this material 3 or 4 feet thick, under which is found a smooth, sticky, bluish mud. At the bell buoy there is found a coarse white sand, containing about 5 per cent of broken shell. Over a considerable area east of the bell buoy the bottom is composed of sticky, dark-blue mud, with traces of sand on its surface. This same material was shown by the lead during soundings to be present over other large areas, notably in the deep channel inside of the bar, in the southerly slough channel, and at the back of the north shoals. Fifteen hundred feet east of the bell buoy the bottom is of fine gray sand, with traces of mud and broken shell. Midway between the bell buoy and the sea buoy there is a coarse white sand, containing about 20 per cent of small broken shell. At the sea buoy there is found a mixture of about 80 per cent of fine gray sand and 15 per cent of fine shell, with traces of brownish mud.

WINDS AND STORMS.

Records of the directions and velocities of the winds at St. Simon entrance were obtained from the reports of the light-keeper at St. Simon light-house. These cover a period of three and one-half years, beginning January, 1888, and from them have been compiled the following tables:

Wind movement.

Month.	Number of days.									Relative force (miles per hour).							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.*	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Jan	1.2	6.7	0.7	3.0	0	5.0	5.5	7.7	....	6	41	3.0	18	0	19	29	36
Feb	1.0	4.0	0.2	3.2	0	7.2	4.7	4.5	....	3	43	2.0	14	0	29	25	29
Mar	0.7	7.0	0.2	2.7	0	5.7	4.7	8.2	....	2	51	1.0	14	0	34	19	49
Apr	2.0	6.7	1.0	5.2	0	6.0	3.7	3.0	....	7	47	3.0	30	0	24	24	19
May	0.5	3.7	2.0	5.5	0	10.5	4.2	3.2	....	1	22	6.0	29	0	47	12	9
June	0.5	3.5	0.7	6.7	0	11.0	5.0	1.7	....	1	13	2.5	36	0	35	18	7
July	0.2	4.0	0.7	5.2	0	14.0	4.2	2.5	....	1	27	1.5	25	0	46	17	4
Aug	0.6	6.3	1.3	6.0	0	8.6	3.6	1.6	....	2	35	4.0	32	0	30	9	6
Sept	2.0	6.6	2.3	5.3	0	6.6	4.6	2.0	....	8	39	11.0	22	0	21	18	8
Oct	1.0	5.6	0.6	2.3	0	4.0	7.6	8.0	....	2	22	2.0	16	0	19	41	39
Nov	1.0	12.0	0.0	2.0	0	2.6	2.6	8.6	....	3	63	1.0	10	0	12	13	41
Dec	2.3	6.6	0.6	2.3	0	1.3	6.3	10.0	....	13	33	2.0	17	0	6	27	54
Total	13.0	72.7	10.3	49.4	0	82.5	56.4	61.0	20.0	39	436	390	263	0	322	252	301

* Or light variable wind.

Wind movement during one year.

Wind blows from—	Number of days.	Per cent.	Average rate (miles per hour).	Relative effect (number of days × miles per hour).	Per cent.
North	13.0	.036	3.0	39	.023
Northeast	72.7	.200	6.0	436	.264
East	10.3	.029	3.8	39	.024
Southeast	49.4	.135	5.3	263	.159
South	0.2	.001	0.0	00	.000
Southwest	82.5	.226	3.9	322	.195
West	56.4	.154	4.5	252	.153
Northwest	61.0	.167	5.0	301	.182
Calm	20.0	.055	0.0	00	.000
	365.0	1.000	....	1,652	1.000

Maximum velocities.

Date.	Direction.	Velocity (miles per hour).	Duration (hours).	Date.	Direction.	Velocity (miles per hour).	Duration (hours).
Mar., 1888	SW	30	24	Apr., 1890	NE	25	16
Dec., 1888	SE	30	24	Do	NE	25	48
Apr., 1889	W	25	8	May, 1890	SE	25	8
Sept., 1889	SE	30	8	Oct., 1890	SE	25	8
Jan., 1890	NE	30	24	Dec., 1890	NW	25	8
Mar., 1890	NE	25	8	Feb., 1891	W	30	8

Northeast, east, and southeast winds are on shore and have the greatest effect on the shoals and shore line. North and south winds are approximately parallel to the shore line, but still have some effect in moving the sands. Southwest, west, and northwest winds are offshore and can have but little effect in wave action, except within the entrance. They do, however, sweep large quantities of sand that have been heaped up on the sand dunes by the onshore winds back into the sea. It may be seen from the foregoing tables that the prevailing direction of the onshore winds is northeasterly, 20 per cent of all the winds being from this direction. Their average velocity is also greater than that in any other direction, which gives to them a relative effect equal to 26½ per cent of the whole. The winds that produce a southerly motion of sand along the coast, viz, north and northeast winds, occur on an average 86 days in one year and have a relative effect of 29 per cent. South and southeast winds, which produce a northerly movement of the sands, occur on 50 days, with a relative effect of 16 per cent; and easterly winds, which probably pro-

duce an inward movement of sand toward the entrance from both sides, occur on 10 days, with a relative effect equal to about 2¼ per cent of the whole. The resultant direction of the wind-wave forces is therefore toward the south, and the positions and forms of the outlying shoals are such as would be expected with a southerly movement of the sand along the coast. Northeast winds are most frequent during the fall and winter months; southeast winds are most frequent during the summer months. Heavy gales are of rare occurrence. Their prevailing directions during the past four years have been southeast and northeast. The northeast gales are generally of longer duration than those from other directions.

MAPS AND DIAGRAMS.

The map of this survey has been polyconically projected on a scale of 1:9,600, the area covered being too large to be conveniently plotted on the usual scale of 1:4,800. This map shows all the soundings taken, together with the 6, 12, 15, 18, and 24-foot curves of equal depth, the shore lines as they existed in January and May, 1891, the principal topographical features near the shore, the triangulation points, and the directions and velocities of observed currents. An index map has also been prepared on a scale of 1:19,200, on which the 15, 18, and 24-foot areas have been shaded to different intensities, to show graphically the varying depths. A sketch of Brunswick Harbor is submitted, showing the positions of tide gauges and bench marks, with the elevations of the latter. The principal tidal conditions are shown graphically by a series of diagrams in five sheets, and a sixth sheet shows the cross section at the entrance, with mean velocity curves and mean discharge.

I wish here to state that in the execution of this survey valuable assistance was rendered by Mr. M. P. Paret, assistant engineer.

During the progress of the survey I received from you the following letter:

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., January 22, 1891.

SIR: So far as I have been able to ascertain pilots report that anchors do not hold so well on the flood as on the ebb tide on the ocean bars in this locality. Two explanations are offered by them: One, that the incoming tide beats down the sand and makes the bars harder; the other, that the sand during flood tide is "alive," and that the continual drifting in this manner renders it difficult for the anchors to hold.

I should be glad if you would look into this matter as far as possible in connection with the survey now in progress under your charge.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

Lieut. THOS. H. REES,
Corps of Engineers, U. S. A.

In accordance with these instructions considerable investigation and study were given to this subject and no evidence could be found upholding the former of the above hypotheses. On the contrary, everything tended to prove the correctness of the second explanation. By wading along the beach or on the shoals during low water it was found that while the ebb currents continued the bottom was firm and compact and it was impossible to force even the flat blade of an oar into the sand more than an inch or two. As soon, however, as flood currents were established the bottom became soft and loosened, the feet would sink into the sand, which seemed to be washed away from around them and the slightest motion would throw the sand into suspension. An oar could now be forced some distance into the bottom. While some experiments with dynamite, with a view to deepening the bar, were being carried on by the city of Brunswick during the months of July and August last, the diver who was employed in sinking the charges was questioned in regard to the character of the bottom during ebb and flood tides, and he stated that during the ebb the bottom was hard and smooth, but on a flood tide the sand was "alive" and the bottom soft and shifting. And further, that during ebb tide the water was generally clear, unless "roiled" by stormy weather, so that he was able to see quite distinctly; while during flood tide the water was always so turbid that he was in total darkness at the bottom and could see nothing. He also stated that he had found these same conditions to exist at all the sandy harbors of the Atlantic coast where he had been employed in diving. The consensus of opinion among the pilots of Brunswick Harbor was that the bottom was "alive" during flood tide and hard and firm during the ebb, and my own observations during the progress of this survey lead me to the same conclusion.

The existence of this difference in the condition of the sea bottom near shore during ebb and flood tides being established, it is natural to seek some explanation

for so singular and important a phenomenon, and a possible one is found in the difference of hydraulic levels that is maintained by the tidal wave as it approaches the shore. During flood tide the greater elevation of surface exists out at sea and the water flows in toward the region of lesser height near shore, not only over the bottom, but it seeks also to find a way through the saturated sands and mud of the bottom, and on emerging from them it lifts and stirs the sand, producing the condition known as "live sand." As the reverse slope of the tidal wave approaches the shore the lesser elevation of surface exists out at sea and ebb currents are established, the seaward flow taking place not only over the sands but seeking also to penetrate them, and this tendency of the water to flow into the sand near the shore compacts and hardens it, thus producing the condition described as existing during ebb tide.

Whether this is the correct explanation or not it can not be doubted that the condition of "live sand" attendant on the flooding of the tide must exercise a marked influence on the resultant direction of sand transportation by the tidal currents. It may in part be the cause of the gradual shoaling that is taking place on the outer bars and shoals at nearly all of the South Atlantic harbors where the conditions are not complicated by fresh-water flow.

This subject seems to the writer to be one deserving of more thorough investigation and study than has been accorded it in the past, with the possible result of throwing more light on the nature of the forces that control the formation of our harbor entrances.

DESCRIPTION.

Brunswick Harbor is one of the many deep and irregular indentations of the coast that exist near the apex of the reëntrant angle formed by the shore line of the South Atlantic between Cape Hatteras and Cape Canaveral. It comprises St. Simon Sound, Brunswick River, and the lower portions of Turtle and East rivers. The entrance to St. Simon Sound is about one statute mile in width and lies between St. Simon Island on the north and Jekyl Island on the south. Just within the entrance the sound branches into two main arms extending toward the north and south. The northern arm divides immediately into three branches, viz, Frederica River, Mackays River, and Back River, which continue in a northerly direction and open into Altamaha Sound. The southern main arm of the sound is called Brunswick River. It turns to the west and northwest and branches into East River and Turtle River, on the former of which is situated the city of Brunswick. East River rejoins Turtle River about 3 miles above its lower mouth.

In the lower harbor there is an anchorage area with depths exceeding 20 feet at mean low water of about 2,000 acres, and, in addition to this, low-water depths of from 20 to 30 feet are found in Turtle River for a distance of about 6 miles above Brunswick. The total area of the harbor is about 20 square miles. There is a channel exceeding 20 feet in depth at mean low water from the lower mouth of East River nearly to the bar.

In the gorge between St. Simon Island and Jekyl Island there are in the northern half maximum depths of 91.5 feet at mean low water, and a mean depth of 58.8 feet. The southern half of the entrance is almost completely choked up by a shoal extending from the northern end of Jekyl Island and rising nearly to the level of mean low water. It is indeed completely bare at low water of spring tides. The deep water at the entrance is prolonged seaward nearly in a straight line, but gradually widening and shoaling until the bar is reached, where a low-water depth of but 13.2 feet is found. The bar is part of a continuous line of shoals inclosing the inner deep water in the form of a horseshoe. It is, however, remarkably narrow, the inner and outer 15-foot curves approaching each other to within 600 and 700 feet, and the 18-foot curves being separated by a distance of only about 2,400 feet.

An unusual circumstance in connection with the form of the seaward slope is found in the deep pocket that cuts into the shoals almost to the bar, making an indentation in the outer 15 and 18 foot curves over a mile in length. The outer 24-foot curve crosses the mouth of this deep pocket without any inward tendency. There is thus formed a sort of roadstead between the outer shoals beyond the bar.

The shoals north of the deep inner channel, called the north breakers, have a very steep slope on the inner side, which brings their crest close to the channel and a gentle slope on the northern side, reaching a depth of 15 feet about a mile from the crest.

Close to St. Simon Island a flood channel nearly 12 feet in depth cuts across the shoals to the deeper water beyond them, and half way to the bar there seems to be a tendency toward the formation of another lateral channel across the shoals. The south shoals have very gentle inner and outer slopes and spread over a wide area, extending indeed to the deep water behind the northern shoals at St. Andrews

Sound. There is a secondary channel having nearly an equal capacity with the main channel, that branches from the latter half a mile inside the bar and cuts through the south shoals in a southerly and southeasterly direction. The inner and outer 15-foot curves on this line are about 2,800 feet apart. Between this and the main channel are shoals that in places do not exceed 6 or 7 feet in depth at low water. They extend farther seaward than do the northern shoals and, together with the inner south shoals, are called the south breakers. The crest of the bar is 4 miles from the shore of St. Simon Island. The 12-foot curve of the north shoals extends seaward nearly a mile beyond the bar, and that of the south shoals extends about 1¼ miles beyond that point, while between them is the deep water of the outer roads.

CONTROLLING FORCES AND MOVEMENT OF SAND.

Sufficient evidence has been presented in the foregoing pages of this report to show that the resultant direction of the forces that move the sand and mold the shoals is toward the south. About one-half of all the winds are onshore winds, and of the latter, those that produce a southerly movement of sand, are to those producing a northerly movement in the proportion of 29 to 16. Moreover, the storms of greatest force and longest duration are from the northeast, and the probable existence of an offshore southerly current has been shown. An examination of the various harbor entrances in this vicinity shows in each case a southerly deflection of the outer portion of the main channel, a long and narrow shoal bordering the channel on the north, with abrupt slopes on the inner side and a flatter slope on the outer side, and a wide-spreading shoal south of the channel extending to the deep pocket behind the northern shoals of the next entrance toward the south. A swash or flood channel generally exists close to shore, from the deep water behind the northern shoals to the inner main channel.

These conditions indicate that the sand carried by the waves and the flood currents into the inner channel is picked up by the more concentrated ebb flow and borne seaward. The dispersion of the currents toward the north and south distributes some of the suspended material over the north and south shoals, and the remainder is carried toward the bar, where the currents have become so weakened by dispersion that they are compelled to drop much of their load, and thus the bar is formed.

The material carried over the north shoals is met by the general southerly tendency of the drift, so that it is deposited close to the channel in the form of a long and narrow shoal. That which is borne to the south, on the contrary, is urged on by the southerly drift, and scattered widely, forming the broad expanse of the south shoals.

These movements probably take place little by little, and with many steps backward, but the general movement of sand is believed to be in the directions indicated.

CHARACTER OF BAR AND CHANGES.

The material of the surface of the bar consists of about 70 per cent of medium gray sand and 30 per cent of broken shell, with traces of fine gravel, or rather of a coarser sand. This material is only 3 or 4 feet in thickness and beneath it is found a dark blue sticky mud, the depth of which is unknown, but is probably very great. This mud is similar in character to the marsh mud that covers extensive areas on shore. When freshly brought to the surface it has a strong sulphurous smell, which it gradually loses by exposure to the air. As it dries it turns to a light slaty color and hardens. While under water it is very soft and easily eroded.

A comparison of the present survey with an examination of the bar made in May, 1887, by Lieut. J. E. Pillsbury, U. S. Navy, of the U. S. Coast and Geodetic Survey, shows that the inner 6, 12, and 18 foot contours of the north breakers, just inside the bar, have moved to the south from 150 to 200 feet; that the inner area inclosed by the 18-foot curve has widened and moved to the south, and that the outer 18-foot area has also moved to the south. There has been no seaward or shoreward movement of these 18-foot curves during the intervening period. There has, however, been a movement toward the bar of the 12-foot curve of the north breakers, which has practically closed the old north channel, in which there was a depth of 14 feet in 1887. A general shoaling toward the north and deepening toward the south of the bar channel has taken place, moving the channel about half a mile south of its former position, so that instead of making a wide détour to the north the present channel curves slightly to the south, but resumes its former position beyond the bar.

A survey made in the year 1856 shows that there was then a depth on the bar at low water of 15 feet. A shoaling of about 2 feet has, therefore, taken place since that time. The deep pocket inside of the bar has also shoaled to some extent. The

outer deep pocket beyond the bar was formerly inclosed by the 18-foot curve, with a second 18-foot curve on the seaward slope. This region has deepened so that there is now not less than 19.5 feet between the bar and deep water at sea.

Early charts show the 6-foot curve to have been continuous around the north breakers. This curve is now broken through by a slough channel that crosses the shoals at a point midway between the shore and the bar, with depths of from 7 to 9 feet, and the southern slope of the shoals is deeply indented by the 12-foot curve. The flood channel near St. Simon Island has deepened slightly. No marked changes have taken place on the south shoals.

COMMERCE.

No additional data concerning the commerce of the port of Brunswick has been collected since your report thereon to the Chief of Engineers for the year 1891 was submitted. I can not hope to present any more fully and forcibly than is there presented the commercial importance of Brunswick Harbor, and I have, therefore, taken the liberty of inserting that report herein, adding such comments as seem pertinent with relation to the improvement of the outer bar.

"Previous to the year 1871 the city of Brunswick was of slight commercial importance, the value of the exports for that year being less than $500,000. In 1875 the value of the total exports had increased to $639,000. From that year up to the present, and especially since 1880, the importance of the city of Brunswick has increased with remarkable rapidity, and this rapid growth has been healthy and steady, with the exception of the year 1889, when the business of the port showed an increase of 50 per cent over that of the year immediately preceding.

"In 1880 the population of Brunswick was 2,891; it is now estimated at 12,000, and is still growing at the same rate. Taxable property has increased in value from $1,300,000 in 1880 to $6,000,000 in 1890. The naval-stores business did not begin here until 1875, but now there is a yearly business of more than $1,000,000. During the same period the lumber business shows an enormous increase. The supply of yellow pine timber is within easy reach of this port, and is practically inexhaustible. White oak, ash, cypress, hard woods, American mahogany, and live oak are accessible within short distances, and all other classes of hard woods are attainable in unlimited quantities from Alabama, Tennessee, and north Georgia. In 1880 there were shipped from this port 37,000,000 feet of lumber; in 1890 the shipments of lumber amounted to 191,141,000 feet, valued at $1,914,145. These figures show an increase of about 75 per cent in the amount shipped, and the values given show a decrease in the price per thousand feet. Lumber was at one time the chief export of Brunswick, but cotton now holds that place. The exports of this staple during the season of 1884-'85 amounted to but 4,000 bales. Since then the exports of this article have increased wonderfully, and 187,446 bales, valued at $8,605,942, were shipped during the season of 1889-'90.

"Two railroads, the East Tennessee, Virginia and Georgia and the Brunswick and Western, terminate here, the former reaching, with its connections, the North and Northwest, and the latter extending across Georgia into Alabama and beyond.

"The following lines of steamers have been established:

"Mallory Line, Brunswick to New York, one steamship per week.
"Brunswick to Savannah, two steamers per week.
"Brunswick to Fernandina, one steamer per day.
"Brunswick to Darien, one steamer per day.
"Brunswick to river points, seven steamers per week.

"The passenger traffic to and from New York over the line now in operation would be greatly stimulated were the outer bar improved so that the steamship company could positively announce the departure of its steamers from Brunswick at the same hour every sailing day, irrespective of tides. The inward bound steamers are often compelled to wait outside the bar for high water, and this circumstance tends to retard the development of the inward passenger traffic. Even with this disadvantage to contend with, the passenger traffic to and from New York over the Mallory Line showed an increase in 1890 of 20 per cent over the previous year.

"Besides the lines of steamers previously mentioned, a large fleet of foreign and coastwise steam and sailing vessels is engaged in the Brunswick trade, which consists principally of shipments of cotton, naval stores, and lumber.

Shipments, foreign and coastwise.

Articles.	1888.			1889.			1890.		
	Amount.	Value.	Tons.	Amount.	Value.	Tons.	Amount.	Value.	Tons.
Cotton ....bales..	82.471	$4,373,291	20,618	171,607	$8,117,126	42,902	187,446	$8,605,942	46,861
Rosin ......barrels..	195,000	390,000	24,375	190,000	380,000	23,750	182,953	365,906	21,619
Turpentine....do...	57.133	677,033	13,134	45,000	787,500	10,345	43,984	791,712	10,150
Lumber.....M feet..	88,274	1,182,985	214,027	110,000	1,540,000	266,200	191,141	1,914,145	349,648
Cross ties .number..	159,000	60,000	15,000	204,000	81,600	20,400	265,000	106,000	26,500
Miscellaneous.tons .	316	7,905	316	1,132	28,289	1,132	3,034	75,872	3,034
Total........	....	6,691,214	287,470	....	10,934,515	364,729	....	11,859,577	457,812
Estimated receipts by water, foreign and coastwise....	....	2,937,426	117,500	....	3,783,000	151,300	....	3,937,500	157,600
Total commerce......	....	9,628,640	404,970	....	14,717,515	516,029	....	15,797,077	615,412

"These figures show an increase of nearly 50 per cent in the trade of 1889 over that of 1888, while the tonnage of 1890 shows an increase of about 20 per cent over that of the preceding year.

"Persons interested in the trade of Brunswick estimate that owing to the past works of improvement in the harbor freight rates have been reduced from 18 to 20 per cent, and that if the improvements were completed according to the existing project the total volume of trade would be increased 200 per cent."

Brunswick Harbor, with its former low-water depth of 15 feet on the outer bar, acquired the reputation of being a deep-water port, and the rapid growth and prosperity of the city are largely attributable to that reputation. The gradual shoaling of the outer bar and consequent limitation of the advantages of this magnificent harbor to vessels of lighter draft, work greater injury to her commercial interest than would have resulted if a greater depth on the bar had never existed, for deep-draft vessels still seek this port for cargoes, expecting ample accommodation, and are frequently compelled to wait several weeks for suitable conditions of tide and wind to cross the bar, or are compelled to put to sea with incomplete cargoes. The commercial importance of Brunswick has already been recognized by the General Government in the works of improvement of the inner harbor, with what beneficial results, may be seen from the foregoing quoted report.

The citizens of Brunswick have become alarmed at the threatening blow to their commercial interests, and on two occasions have sought by their own efforts to obtain an increase of depth on the outer bar. At the first trial, nearly three years ago, the method of harrowing was adopted, but an increase in depth of only a few inches was effected. Again, during the months of July and August last, an experiment was made in the use of dynamite as a means of throwing the material of the bottom into suspension to be borne off by the currents; but though considerable material was moved, it resulted only in a slight seaward movement and narrowing of the bar, without any material increase in the depth.

The thorough railway communication between Brunswick and the interior, extending far to the northwest and west; and her excellent terminal facilities, capable of almost indefinite extension; as well as the remarkable growth in commercial importance, as shown by her past history, lead to a confident faith in her future growth and prosperity, provided these are not checked by the deterioration of her harbor, and to the belief that there will be an ample return to the country in the benefits that will accrue to the shipping interests of this region, for any reasonable outlay that may be required in improving Brunswick outer bar.

PLAN OF IMPROVEMENT.

A channel across the bar 300 feet in width and 26 feet deep at mean low water could be obtained by dredging alone by the removal of about 224,000 cubic yards of material in place and at a cost, in round numbers, of $130,000. Such a channel would not, however, be permanent, but would require large annual expenditures for maintenance. The actual cost of maintenance can not be closely estimated, but it would probably be from $50,000 to $75,000 per year, and even then it would not be entirely effective. Experience on similar bars at South Atlantic and Gulf harbors has shown that an attempt to deepen the bar by dredging alone is not met by decreased action of the deteriorating forces, but that a continual struggle against them must be maintained. Storms may in a short time almost obliterate the effects of previous work, while they will at the same time and for longer periods prevent the adoption of any measures for relief. In such cases deep-draft vessels might be caught within the harbor by the sudden shoaling of the channel and detained for

long periods while the slow process of dredging to the former depth was going on. The uncertainty as to the depth to be expected on the bar would be a constant source of embarrassment and possible loss, and would prevent the full use of the greater depths, even when they existed. For these reasons improvement by dredging alone is not recommended.

In the consideration of a plan of improvement by means of jetties it is assumed that if velocities are induced across the bar approximately equal to those that now exist at the entrance where such great depths are maintained, they will be amply sufficient to maintain the proposed depth of 26 feet at mean high water throughout the channel to the sea. To this end an effective cross-sectional area for tidal flow between and over the jetties must be allowed, fully equal to that at the entrance. No greater contraction than this of the cross-sectional area is permissible, because it is essential not only to the improvement of the outer bar, but also to that of the inner harbor now in progress, that the tidal conditions of the inner basin remain unchanged.

The province of a northern jetty is to check the southward movement of sand across the north shoals and prevent its being washed into the channel and carried to the bar by the ebb currents, and in conjunction with the south jetty to confine the currents and train them in the most favorable direction across the bar. Its position is practically determined by the direction of the outer channel and the location of the north shoals with reference thereto. The jetty should be placed beyond the crest of the shoals to avert the possible danger of its being undermined should the increased currents erode the inner slopes to a serious extent. A position about 1,600 feet from the northern edge of the outer channel is chosen as a safe one, and the line of the jetty is made parallel with the axis of this portion of the channel. This line produced strikes the shore perpendicularly at a point about three-quarters of a mile from the entrance. There is, therefore, no necessity for any change in the direction of the north jetty. As to its height, the shore end should be raised to the level of mean high water until the region of breaking waves is past, or say, till a low-water depth of 6 feet is reached. The crest may then be dropped to the mean elevation of surface at the beginning of ebb flow, and this height should be maintained seaward until a slight southerly inclination of the ebb currents conforming with existing tendencies has been effected. This determines the height for a distance of 13,600 feet from shore. From this point to the crest of the bar the jetty may be raised only to the height of mean low water; and beyond the bar it may slope gradually to the level of the foundation course at its outer end on the 18-foot curve, 24,800 feet from shore.

A southern jetty will be necessary to prevent the erosion of the south shoals and the breaking through of lateral channels in this direction and to assist the north jetty in confining the main currents to the proposed channel. Its outer end, from the inner slope of the bar seaward, should be parallel to the opposite portion of the north jetty. If placed at a distance of 5,000 feet from the north jetty, the least cross-sectional area at low water between the jetties will be about 71,000 square feet, nearly one-half of that at the gorge. This places the south jetty well over on the shoals, where any increase in channel width would not be attended by any great increase of cross section and would be followed by a loss of concentration in the flow through the jettied channel. It is proposed to furnish the additional cross-sectional area necessary to maintain its equality with the gorge area, by keeping the crest of the jetty low. The shore arm extending perpendicularly from the Jekyl Island shore until a depth of 6 feet at low water is reached, is so placed as to include between its outer end and an opposite point of the north jetty a high-water cross-sectional area fully equal to that at the entrance. The shore arm and outer arm are connected by a broken line, as shown on the chart. The shore arm is proposed to be raised to the level of mean high water until the region of breaking waves is past, or till a depth of 6 feet at low water is reached. The height of the remaining portion must be such as to furnish over its crest the cross-sectional area necessary to maintain unchanged the present tidal conditions in the inner harbor and to produce the proper current velocities. This will be attained by keeping the crest 8 feet below the level of mean low water.

When the strengthened tidal currents, assisted by dredging if necessary, have scoured a deeper channel across the bar and thus increased the cross-sectional areas between the jetties, it may be found advisable ultimately to raise one or both jetties to a greater height, in order to keep sand out of the channel and to maintain the increased current velocities.

A form of construction similar to that adopted for the jetties at Cumberland Sound is proposed, with such changes as are rendered necessary where the heights are greater or the degree of exposure is different. For the foundation courses, brush mattresses 100 feet in width, loaded with rip rap stone, are proposed; above this alternate courses of brush mattresses and rip rap stone, to be used as high as the process of complete sanding over continues, which, for those portions of the jetties inside of the bar will probably be at least to a level of 6 or 7 feet below mean low water. The remainder of the jetty to low-water level to be built of rubble stone, none of which above a depth of 3 feet at low water should weigh less than 250

pounds. Below that depth the stone may weigh from 50 to 250 pounds. Where the jetty rises above low water a capping of blocks of stone or concrete weighing from 3 to 4 tons is proposed. Suitable stone for this purpose is not obtainable within a reasonable distance and concrete would probably be used.

It is assumed that a crest width of 10 feet at mean low water, with side slopes of 1 on 2 to a depth of 3 feet, and of 1 on 1.5 below that depth, will give a form of cross section sufficiently stable for the depths in which these jetties are to be placed.

To prevent the possible flanking of the jetties by storms and high tides each should be provided with a shore extension or sand catch.

The order of construction recommended is to construct the shore extensions, shore arms, and foundation courses of both jetties simultaneously in order to hold the beaches and shoals and prevent changes that might otherwise take place during the progress of the work. Next, to raise the north jetty to the level of mean low water. Then, to complete the south jetty, and finally to place the capping on the north jetty. While the south jetty is being constructed, the completed portion of the north jetty will have had time to settle and will be in a condition to receive its load of concrete blocks.

If the erosion of the channel to the required depth is not accomplished by the increased currents, they should be assisted by dredging, and this has been included in the estimates.

ESTIMATES.

North jetty:	
100 feet shore extension, at $20 per foot	$2,000
20,000 cubic yards concrete, at $12 per cubic yard	240,000
37,000 cubic yards large rubble, at $6 per cubic yard	222,000
190,000 cubic yards ordinary rubble, at $3.50 per cubic yard	665,000
365,000 square yards mattresses, at $1 per square yard	365,000
Total for north jetty	1,494,000
South jetty:	
100 feet shore extension, at $20 per foot	2,000
3,200 cubic yards concrete, at $12 per cubic yard	38,400
16,000 cubic yards large rubble, at $6 per cubic yard	96,000
77,500 cubic yards ordinary rubble, at $3.50 per cubic yard	271,250
458,000 square yards mattresses, at $1 per square yard	458,000
Total for south jetty	865,650
North jetty	1,494,000
South jetty	865,650
Dredging 224,000 cubic yards, at 50 cents per cubic yard	112,000
	2,471,650
Engineering and contingencies, 10 per cent	247,165
Aggregate	2,718,815

In conclusion, I wish to acknowledge the valuable suggestions and assistance that I have received from you, and that have been freely used in the preparation of this report.

APPENDIXES.

There are submitted herewith the following maps and diagrams:

1. Map* of Brunswick Outer Bar and entrance to St. Simon Sound, showing soundings, curves of equal depth, and velocities and directions of currents. Scale, 1: 9600.
2. Tracing* of Brunswick Outer Bar and entrance to St. Simon Sound, giving characteristic soundings, curves, and currents. Scale, 1: 9600.
3. Index map* of Brunswick Outer Bar and entrance to St. Simon Sound, showing location of jetties. Scale, 1: 19200.
4. Sketch* of Brunswick Harbor, showing position of tide guages and bench marks.
5. Sketch* of entrance to St. Simon Sound, showing distribution of ebb flow.
6. Diagrams of tidal conditions,† in six sheets.

Very respectfully, your obedient servant,

THOS. H. REES,
First Lieut., Corps of Engineers.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

*Not reprinted; printed in House Ex. Doc. No. 34, Fifty-second Congress, first session.

†Not printed.

APPENDIX O.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN FLORIDA.

REPORT OF MAJOR J. C. MALLERY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., July 11, 1892.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1892.

Very respectfully, your obedient servant,

J. C. MALLERY,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

O 1.

IMPROVEMENT OF ST. JOHNS RIVER, FLORIDA.

The portion of the river under improvement from Jacksonville to the ocean may be divided into four reaches, as follows:

1. Jacksonville to Dames Point: Length, 12.4 miles; average channel width between 20-foot contours, 1,100 feet; between 15-foot contours, 1,300 feet; minimum 15-foot channel width, 550 feet; minimum mid-channel depth, 20 feet; mean range of tide, 1.4 feet.

2. Dames Point to Beacon No. 1 (1 mile below St. Johns Bluff): Length, 7.5 miles; aggregate length of channels less than 15 feet deep, 1.3 miles; average width of these channels between 9-foot contours, 400 feet; minimum mid-channel depth of defective portions, 12.5 feet; minimum mid-channel depth of remainder of reach, 15 feet; range of tide, 2.72 feet.

3. Beacon No. 1 to mouth: Length, 5 miles; average width between 20-foot contours, 700 feet; between 15-foot contours, 870 feet; minimum mid-channel depth (except at one place 1 mile long), 20 feet; depth at excepted place, 15 feet; range of tide, 4.34 feet.

4. Mouth to outer bar: Distance, 2.5 miles. Before the improvement was begun this was crossed by shifting channels from 2.1 to 2.5 miles long and having a mean low-water depth of from 5 to 7 feet. The tidal range on the outer bar is 5.8 feet. There are two channels across the bar. The north channel crosses the line of the prolongation of the north jetty axis at a slight angle. It has a least mean low-water depth of 10.5 feet, found on the crest of the bar. The south channel, that used by vessels, crosses the line of Ward Bank and the prolongation of the south jetty axis, passing close to the end of the jetty. It has a least mean low-water depth on the bank between the jetties of 14.5 feet, and on the outer bar of 11.5 feet.

PROJECT OF IMPROVEMENT.

The operations for improving this channel have been carried on in accordance with a project submitted to the Chief of Engineers June 30, 1879, by the late Gen. G. A. Gillmore, Colonel, Corps of Engineers, and printed as part of Appendix I 7, Annual Report of the Chief of Engineers for 1879.

The approved project is to obtain a least mid-channel depth of 15 feet at mean low water from Jacksonville to the ocean. This depth is to be obtained across the bar at the mouth by concentrating and directing the flow of the river by two long jetties, starting from opposite shores of the entrance and converging until, near their outer extremities on the bar, they shall be 1,600 feet apart. The jetties are to be built of riprap stone on mattresses of log or brush and suitably capped. According to a detailed project approved June 11, 1891, and approved in a modified form March 30, 1892, the ship channel in the defective reach, Dames Point to Beacon No. 1, is to be deepened by dredging and protected by dikes and shore revetment of cheap construction. This work is now being carried out by means of an appropriation of $300,000 made for the purpose by Duval County. The estimated cost of this portion of the work is $324,000, and of the entire improvement $1,741,000. Gen. Gillmore's original estimate was $1,426,000. The increase in cost is due mainly to the increase in the depth of water in which the jetties must be built, caused by the scour around the ends during the long period of time in which the work has been carried on, and to other effects of the intermittent prosecution of the work, and finally to the increased depth as proposed by the modified project for Dames Point.

OPERATIONS PRIOR TO JUNE 30, 1891.

Operations were carried on under seven appropriations, viz:

By act approved—	
June 14, 1880	$125,000
March 3, 1881	100,000
By act passed August 2, 1882	150,000

By act approved—	
July 5, 1884	$150,000
August 5, 1886	150,000
By act of August 11, 1888	175,000
By act approved September 19, 1890	170,000
Total	1,020,000

Of these the first five were for improving the channel over the bar at the mouth only. The last two were available for the complete project. The work was done almost entirely by contract as funds were available. On June 30, 1891, the progress of the jetty construction was as follows:

South jetty.—Total length of jetty, including shore extension, 7,147 feet; length at full height and capped, 1,740 feet; additional length above low water, except a few small gaps at outer end, 4,680 feet; depth over remaining length of 727 feet sloping from mean low water to 13 feet below. The total amount of materials of construction used is as follows: 203,063.6 square yards of log and brush mattresses; 81,508.8 cubic yards of riprap stone; 2,880.83 cubic yards of oyster shell, and 218 cubic yards of concrete.

North jetty.—Total length, including shore extension, 10,165 feet; length at full height and capped, 553 feet; additional length above mean low water, excepting a few gaps, 6,514 feet; average mean low-water depth over the remaining length of 3,098 feet, 5 feet. The total amount of materials of construction used is as follows: 112,364 square yards of log and brush mattresses; 79,931 cubic yards of riprap stone; 5,325.41 cubic yards of oyster shell, and 337.8 cubic yards of concrete.

Dredging operations were carried on from October to December, 1890, at the entrance and at Dames Point Reach, without, however, achieving a permanent deepening at either place.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

Work on the jetties was continued under the contract of December 3, 1890, with Mr. Marcus Conant, approved December 24, 1890. Up to June 30, 14,586 square yards of mattresses, ballasted with 4,495.8 cubic yards of stone, had been placed in the foundation of the south jetty, extending it from Station No. 6667 to Station No. 7813. Besides this, 8,848.6 cubic yards of riprap stone and 849.4 cubic yards of oyster shell were placed in the superstructure of the same jetty in the shore extension and between Stations No. 4940 and No. 6860, filling gaps, strengthening and widening the crest, and building it up to mean low-water and above. Ten thousand seven hundred and seventy-three square yards of mattresses, ballasted with 4,509.3 cubic yards of riprap stone, were placed in the foundation course of the north jetty, extending the same from Station No. 10108 to Station No. 10934. Besides this, 6,154.0 cubic yards of riprap stone and 494.0 cubic yards of oyster shell were placed in the superstructure of the jetty in the shore extension and between Station No. 7001 and Station No. 10700, filling gaps, strengthening and widening the crest and building it up to low water as far as Station No. 9000, and to an average height of 5 feet below mean low water from there to the end. Two hundred twenty-seven and one-tenth cubic yards of concrete coping to a height of 4 feet above mean low water was put in the north jetty for a length of 276 feet from Station No. 6506 to Station No. 6782, part of the blocks

being made in place and weighing from 8 to 10 tons, and part of the blocks being made in Mayport and weighing about 6 tons. This work was done by hired labor entirely.

Other work during the fiscal year comprised partial surveys of the bar made from time to time and the annual survey of the bar and its vicinity.

MATERIALS AND METHODS.

The methods of construction are all generally as explained in former reports.

The stone used was obtained from Florida, New York, and Connecticut.

The concrete capping of the north jetty was made of sand, broken shells, and Saylor's American Portland cement.

PRESENT CONDITION OF JETTIES.

South jetty.—The total length of this jetty, including shore extension, is 8,293 feet, of which 1,740 feet from Station No. —480 to Station No. 1260 is built up to the full height; thence to Station No. 3200, a length of 1,940 feet, the crest of the jetty is above mean low water; thence to Station No. 6860, a length of 3,660 feet, it is about at low water, in some places somewhat below it; thence to the end, a distance of 953 feet, the depths over the jetty vary from 13 to 18 feet at mean low water.

The condition of the jetty remains stable. There has been some lowering of the crest in spots, which was doubtless caused by the action of the sea against the riprap forming the crest, causing it to assume a more stable slope. There is no indication of any subsidence caused by underscour. The concrete blocks of the shore extension (weighing from about 1 ton to 2½ tons) have been somewhat displaced at various points through probably the same agency. The greatest displacements have taken place between Station No. 375 and Station No. 600.

Up to date 217,649.6 square yards of mattresses, 94,925.2 cubic yards of riprap, 3,730.23 cubic yards of shell, and 218 cubic yards of concrete had been used in the construction of this jetty.

North jetty.—The total length of this jetty, including the shore extension, is 10,991 feet. From Station —57 to Station No. 496, a length of 553 feet, the jetty is built up to full height and capped, this portion being entirely covered by sand now excepting the outside end of about 65 feet; thence to Station No. 6506, a length of 6,010 feet, the crest is at and above mean low water, excepting some gaps where the depth varies from 1 to 2 feet; thence to Station No. 6782, a length of 276 feet, the concrete coping of the jetty is 4 feet above mean low water; thence to Station No. 7250, a length of 468 feet, the crest is slightly above mean low water; thence to Station No. 8300, a length of 1,050 feet, it averages about 1 foot below mean low water, and thence to the end, a length of 2,634 feet, it slopes down to a depth of about 10 feet.

There is no indication of any subsidence caused by underscour, excepting perhaps at the lower portions of the outer end. The lowering of the crest is due to the causes mentioned above.

Up to date, 123,137 square yards of mattress; 90,594.3 cubic yards of stone; 5,819.41 cubic yards of shell, and 564.9 cubic yards of concrete had been used in the construction of this jetty.

CHANGES SHOWN BY SURVEY OF 1892.

The shore lines in the vicinity of both jetties are practically unchanged since the last survey.

The distance between the inside and outside 12-foot curves on the bar in the north channel has diminished from 700 feet in 1891 to 300 feet in 1892. The general depth of water on this bar has increased and the area bounded by the 6-foot curve is much smaller. The available mean low-water depths in the south jetty channel across the bar and across the middle ground separating this channel from the north jetty channel are 12 and 15.6 feet, respectively, while in 1891 the corresponding depths were 13 and 11.5 feet.

The south jetty channel has moved still farther southward, with a resulting shoaling across the bar.

It is hoped, however, that the north jetty channel will increase to a depth and width which will permit its early use so that the long delay caused by the necessity of keeping the south jetty channel open across the prolongation of the south jetty may cease.

The annual survey was made by Mr. E. A. Gieseler, assisted by Messrs. L. S. Mattair and P. B. Bird. Mr. F. W. Bruce, the superintendent of the work at the mouth, also aided the work in addition to his regular duties. Mr. Bruce has been in local charge for a number of years, and much of the success is due to his intelligent and energetic zeal and capacity.

Attention is respectfully invited to the report of the annual survey, from which the following conclusions are drawn:

1. That the jetties should not be built at present above mean low water, because, as far as they have been built to that height, they have maintained the depth sought for by the project, viz: 15 feet at mean low water, and because an increase of height would probably diminish the tidal range in the river.

2. Movement of sand between the jetties: Tables are respectfully submitted which show this movement, as given by the cross sectional areas and mean depths at different points from Mayport to the ends of the jetties, since the project has been under execution. In the river proper, *i. e.*, near Mayport, there has been no marked change in either the area or form of cross section or in its mean depth.

There has been a slight shoaling between the jetties near their shore ends where the width is greatest. The jetties have been very efficient in scouring out the channel and in pushing the material seaward. Unfortunately the suspension of work from October, 1889, to February, 1891, permitted the channel to cross the prolongation of the south jetty, and the channel still has this position. This has materially increased the cost of the work, by increasing the depth of water in which the south jetty will have to be built and by the delay incident to the necessity of not interfering with navigation and by permitting the eroded material to be deposited on the bar instead of being carried beyond, thereby increasing the distances to which the jetties must be built and diminishing the energy of the ebb current.

If the success of the work has not been rendered doubtful, the cost has certainly been made much greater by the appropriation of insufficient funds at such intervals as to render continuous work impossible. The result has been that the south jetty channel has nearly closed and the north jetty channel is not yet open.

No conditions approaching permanence can be hoped for until the

jetties are extended and raised to the proper heights across the bar and until the channel is confined between them.

The slow rate of progress made has caused the gradual retreat of the bar seaward, thereby increasing the lengths to which the jetties will have to be built, and introducing unfavorable conditions not only at the mouth, but in the river proper.

The resultant direction of the movement of sand at the mouth is from the north to the south. This is shown in the various maps made before the improvement began, which record the gradual movement of the bar channel from north to south. The channel has been confined, as it were, between two movable jetties of sand, which, under the prevailing conditions, have moved from north to south until the energy of the ebb current has become so enfeebled by the increased length of channel with diminished slope and by the gradual shoaling of the channel across the bar that a new channel breaks out to the north when the same movement south repeats itself. The history of the improvement also demonstrates the same fact, and also shows that the south jetty is the principal factor in determining the direction of the channel and in maintaining it. As long as the south jetty was in advance of the north jetty, the channel was kept to the north of the south jetty for some distance beyond it. The north jetty acts as a breakwater, but does not prevent the movement of sand across it, nor is it possible to prevent this movement without building the jetty to an excessive height, when the sand would accumulate rapidly, causing an advance of the shore line, and would finally overtop the jetty, as it has done at its shore end, which was built to a height of 5 feet above mean low water, and which is now covered with sand and crossed by sand. As it is impossible to prevent this movement of sand across the north jetty without causing more serious complications elsewhere, it seems better to permit this movement, as the ebb current maintains the desired channel.

It is also probable that building the jetties to a height greater than mean low water would diminish the tidal range in the river. I therefore respectfully recommend that the jetties be confined to the height of mean low water for the present, as they have scoured and maintained the desired depth of 15 feet at mean low water even 800 feet beyond the end of the south jetty, and that work be confined to extending the jetties as rapidly as possible to deep water across the bar.

The net scour during the current fiscal year has been about 500,000 cubic yards, and since the improvement began has been about 4,500,000 cubic yards, which have been removed at a cost of 21 cents per cubic yard. From November 1, 1871, to May 31, 1872, a well-equipped self-propelling hydraulic dredge removed from the bar 39,969 cubic yards, at a cost of $19,870, exclusive of the cost of the plant, making the cost per cubic yard 53¾ cents. This work was much interfered with by the shallow and rough water.

Attention is respectfully invited to the plate, which gives profiles of the south jetty at the times of the various annual surveys, and also the profiles along the axis of the channel. This shows the efficient manner in which the south jetty has caused and maintained the channel, and warrants the belief that if the south jetty were extended to deep water across the bar the desired channel depth would be secured.

With reference to the influence of the jetties, as constructed upon the regimen of the river proper, sufficient data have not been collected upon which to base a decision. Such information will be obtained as

soon as practicable. It appears, however, that no loss of tidal range at Mayport has been caused by the construction of the jetties.

The annual survey also gives the direction of the surface current with reference to flood and ebb flow and with northeast and southeast winds, the directions prevailing in winter and in summer, from which it appears that the flood currents cross the south jetty when the wind is in either direction, but cross the north jetty only when the wind is northeast, and that the ebb currents cross the south jetty when the wind is northeast and cross the north jetty when it is southeast, and that the amount of spill is greater over the south jetty.

The ebb and flood flow have also been computed by means of tidal observations and other available data. The following are the results:

At Mayport, 1892, flood flow, 1,200,000,000 cubic feet; ebb flow, 1,683,000,000 cubic feet.

At Mayport, 1878 (as determined by Mr. Daubeney), flood flow, 1,181,000,000 cubic feet; ebb flow, 1,860,000,000 cubic feet.

Gen. Gillmore (Report of Chief of Engineers for 1879, page 781) states, that owing to excessive and unusual rains the fresh-water flow at the time of the gauging in 1878 was doubtless in excess of the average amount and diminished the flood flow.

No definite opinion can be formed as to whether the construction of the jetties has caused a decrease of the tidal prism until more extensive tidal observations have been made and until the river is gauged again at Mayport.

IMPROVEMENT BETWEEN JACKSONVILLE AND THE MOUTH.

The project, approved June 11, 1891, for securing a mid-channel depth of 15 feet in the defective reach between Dames Point and Beacon was slighly modified in the vicinity of Dames Point, which modification was approved on March 30, 1892.

Owing to the small appropriations work has been confined to the bar.

There has been considerable difficulty experienced in navigating the Dames Point Reach owing to the small depths (12 feet in some places) at mean low water, the narrow channels and sharp bends with cross currents, and the small tidal range, amounting to about 2 feet. The county of Duval voted to raise $300,000 to improve this defective reach and obtain a depth of 18 feet at mean low water, and the Secretary of War directed that the approved project be given to the authorities of Duval County for execution. This has been done and contracts have been let by the county authorities for carrying out the project.

The survey upon which the project was based was not sufficiently extensive for a systematic and uniform project for the river from Jacksonville to the mouth to attain a depth of 18 feet, and had merely contemplated securing a depth of 15 feet, the depth aimed at for the bar, nor were there sufficient data on hand for such a project. Owing to the great difference in tidal range at Dames Point and on the bar, 3½ feet in favor of the bar, the county authorities were anxious to work for a depth of 18 feet in the river and were very desirous to commence work at once.

The great loss in current energy between the mouth and Jacksonville, with a loss of tidal range of 4 feet, is due to the great resistance offered to the flood flow by the winding course of the river, making numerous and sharp bends, and the division of the flow into several channels by shoals and islands. Where the river is confined to a single

channel, although the high water width is excessive and the river is winding, there is ample depth.

The current energy is dependent upon the volume and velocity of the flood flow and of the fluvial discharge, the durations of the flood and ebb, the heights of high and low water, the range of the tide at different points, and upon the change in area and form of cross sections of the river.

Sufficiently extensive observations should be made in order to determine these elements and the mean yearly stage by which the mean results are produced, and I respectfully recommend that such observations be authorized, as they are necessary for determining the fundamental elements upon which the permanence of the improvement of the river and of the bar is based, and are necessary in order to fix the height at which the jetties may be raised with safety to the regimen of the river.

During the annual survey tide gauges were established at Mayport, Dames Point, Jacksonville, and Palatka.

Through the courtesy of Mr. Isaac Winston, of the U. S. Coast and Geodetic Survey, the Palatka tide gauge was connected with a bench mark of the line of levels being run to connect tide water on the east coast at St. Augustine with tide water on the west coast of Florida. From the preliminary computations it appears, assuming the planes of mean low and high water at St. Augustine and Mayport to coincide, that mean high water and mean low water at Palatka are about 2 feet lower and 1 foot higher, respectively, than the corresponding levels at Mayport. This loss of effective head is a measure of the various resistances opposed to the tidal flow.

The range of the tide at Mayport is 4.34 feet while at Palatka, and at Jacksonville it is only 1 foot. An increase of tidal range is necessary in order to increase the current energy with consequent increase of depth. This increase of tidal range can be brought about by diminishing the resistances to flow, when the flood current will advance with greater force and to a greater height and the ebb current will flow more freely with the result of a lowering of the ebb surface.

The greater part of the loss of tidal range occurs between Mayport and Dames Point, amounting to 2.57 feet in 10 miles. This is caused by the resistances caused by the numerous sharp bends and by the division of the flow by islands and shoals. The islands and shoals also cause conflicting currents where the channels unite by reason of the more rapid flow through one of the divided channels and exert the most unfavorable influence.

The bends increase the length of the river, consume the energy of the flood current, and cause higher low-water levels.

In order to secure the best results the river should be confined to a single channel with properly proportioned cross sections gradually increasing towards the mouth.

The improvement is located in the collection district of St. John. Jacksonville is the nearest port of entry. Nearest light-house is St. Johns River Light. Nearest fort is Fort Clinch, Fernandina, Fla.

The following papers accompany this report, viz:

Report of Mr. E. A. Gieseler, assistant engineer.
Two sheets of diagrams accompanying the same.
Plate No. 1.—Map of bar and vicinity.
Plate No. 2.—Profile of jetties.

Money statement.

July 1, 1891, balance unexpended		$154, 853. 01
August 10, amount refunded by land-grant railroad		. 88
		154, 853. 89
June 30, 1892, amount expended during fiscal year		93, 448. 41
July 1, 1892, balance unexpended		61, 405. 48
July 1, 1892, outstanding liabilities	$19, 269. 98	
July 1, 1892, amount covered by uncompleted contracts	24, 982. 00	
		44, 251. 98
July 1, 1892, balance available		17, 153. 50
Amount appropriated by act approved July 13, 1892		112, 500. 00
Amount available for fiscal year ending June 30, 1893		129, 653. 50
Amount (estimated) required for completion of existing project		284, 500. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894		284, 500. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. E. A. GIESELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., June 30, 1892.

MAJOR: I have the honor to report as follows upon the survey at the mouth of the St. Johns River, made by me between the 19th of May and the 15th of June, 1892.

The work was done in accordance with the following instructions issued by you:

"In addition to the information supplied by the usual annual survey, I have to request you to report on the following subjects, as far as you may be able to do so, viz:

"1. Whether the tidal range has been reduced by the construction of the jetties?

"2. Whether the jetties should be built above low water, and, if so, what height they should be held at the different portions?

"3. Whether jetties to or above high water would be injurious?

"4. The direction of flood and ebb currents between and adjacent to the jetties.

"5. Whether the flood and ebb currents at present cross the jetties in any definite direction dependent or independent of the wind?

"6. Whether sand is brought in over the jetties, and to what extent, and whether sand is brought back by the flood currents?

"7. Movement of sand during ebb and flood."

In addition to these instructions I had been verbally instructed by you to include in my work a survey of Mile Point Bar and of the shore line from Mayport up to St. Johns Bluff.

1. Annual survey.—The work required for the annual survey was done in the usual way. About 6,000 soundings were taken from Mayport out, covering the usual ground. As many of the soundings as could be conveniently platted and the usual survey of the shore line are rendered on the map submitted herewith.

Soundings taken on the axis of the jetties and rendered in the submitted profile show that the outer portions carried 2 feet above low water have been washed down to a little above low-water level. The concrete capping of the shore end of the south jetty has settled considerably in some places, as apparently has also the structure built around Station I on the north jetty, while the concrete capping commencing a little below that point has stood well. Otherwise both jetties appear in good condition.

Important changes have taken place since the last annual survey in the south channel and the north channel immediately beyond the outer ends of the jetties. The outside 12-foot curve has advanced outward about 400 feet, while the 30-foot curve has remained about stationary. The seaward slope is, therefore, correspondingly steeper now.

The south channel has continued to shift southward and has at the same time shoaled to somewhat less than 12 feet over the bar. The bar across the north channel has advanced seaward, the inner edge, however, considerably more than the outer edge, so that the width of the bar is now about 300 feet against 700 feet at the time of the last annual survey, the depth over it having remained the same, viz, about $10\frac{1}{2}$ feet.

It would seem as if the cycle of changes which the ship channel has been found to undergo from time to time at the mouth of the St. Johns had once more arrived at that stage when the outflow through the long and circuitous route of the south channel is impeded to such an extent that the breaking through the bar of the shorter north channel is imminent, and may take place as soon as a favorable combination of circumstances occurs.

2. *Movements of sand between jetties.*—There are submitted herewith a series of comparative cross sections platted from the various annual surveys since 1883, and covering the ground from Mayport out to the end of the jetties. In the following table the areas and mean depths at mean low water of these cross sections are given, while their location is shown in a sketch submitted herewith.

TABLE NO. 1.—*Low-water cross sectional areas and mean depths at the mouth of the St. Johns River from 1883 to 1892.*

[A.—Cross sectional areas in square feet.]

Number of cross section.	1883.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
82	....	34,850	35,300	38,525	34,250	34,550	36,500	36,150	37,850
83	36,275	40,050	41,000	44,425	42,450	39,400	37,900	41,350	43,400
84	40,650	39,750	43,750	45,900	41,750	39,975	41,650	41,250	39,900
85	36,525	41,100	41,375	46,400	40,400	42,650	41,250	39,150	39,250
86	33,000	29,850	44,100	49,900	43,450	43,100	39,950	41,400	40,200
87	26,000	20,770	26,500	41,950	45,050	46,400	45,650	48,250	43,675
88	....	12,900	14,425	18,850	26,225	33,925	33,775	39,050	40,700
89	....	17,900	13,525	19,500	18,975	21,750	25,950	30,675	32,125
90	....	8,900	13,850	17,650	15,225	16,975	16,250	19,600	23,525

[B.—Mean depths in feet.]

82	....	15.2	15.3	15.7	15.2	15.0	15.2	15.4	16.1
83	12.7	14.0	14.6	15.9	14.9	13.7	12.2	14.0	15.2
84	13.3	12.0	11.1	11.9	10.6	10.6	10.4	11.1	10.4
85	14.2	11.7	11.7	13.7	12.1	12.0	9.8	10.2	9.2
86	8.6	8.1	11.7	13.1	10.9	10.5	9.6	9.6	9.6
87	7.1	5.7	7.2	11.4	12.4	12.7	12.4	13.2	12.5
88	....	6.6	7.9	9.4	12.6	13.0	11.1	12.8	13.3
89	....	8.5	6.6	9.5	9.3	10.6	12.7	15.0	15.6
90	....	5.6	8.7	11.0	9.5	10.5	10.2	12.8	14.7

In the river proper (sections 82 and 83) neither mean depth nor form nor size of cross sectional areas has undergone much change. The characteristic feature here still is, as it has been, a main channel, with depths up to about 30 feet, separated by a shallow middle-ground from a flood channel which ends immediately above.

From the shore end of the north jetty to a point opposite the shore end of the south jetty (sections 84, 85, and 86) cross-sectional areas as well as mean depths have slightly declined, as the jetties were pushed further seaward and the opening between them contracted.

From the shore end of the south jetty to about the 3,500 point on the same (sections 86, 87, and 88) a characteristic feature is the shifting shoal along the north jetty. It seems that this shoal is formed from time to time by large masses of sand transported over the north jetty by the turbulent wave action on the shallow expanse immediately north of the jetty, and that in the course of its development it advances southward, crowding the channel against the south jetty until the increasing currents effectually resist any further advance and commence to erode the shoal, a process which appears to be going on now. But another shoal has already formed and commenced its southward advance from the north jetty, and the same cycle of events will probably repeat itself.

It seems that here the inability of the north jetty to arrest the southward progress of great masses of sand is conspicuously shown, while at the same time the efficiency of the south jetty in protecting the channel and holding it in a permanent location is as clearly established.

The future of the improvement must therefore apparently be sought in the prolongation of the south jetty across the present channel and the "bank" to deep water. If the north channel should break through and widen, then the prosecution of this work would not interfere with navigation, and it is to be hoped that then the necessary means will be available to take advantage of a temporarily favorable

state of affairs in such a way that a rapid and vigorous prosecution of the work may be assured.

As soon as extensive future work can be decided upon, I would respectfully recommend another survey of the bar across the north channel to be made and on the basis of such survey a careful buoying out of the north channel with a view to induce steamers to use it, which would undoubtedly materially aid in further opening it.

3. Height of jetties.—The effectiveness of the south jetty is further illustrated by a sketch submitted herewith, on which are represented in a diagrammatical way and leaving out unessential details, the longitudinal profiles of the south jetty as platted from the annual surveys since 1883. On each profile is shown the thalweg of the channel pertaining to it. It is seen from these sketches that at a time when the north jetty was still quite short (1883 to 1887) a channel was scoured out along the south jetty, and it is further seen that with its crest 5 feet below mean low water this channel was maintained, and with the crest at or near low water it was improved. It seems, therefore, very probable that no height beyond low water is needed to erode and maintain a good channel, and it seems possible that a height somewhat below low water may be sufficient.

From the question of the heights of jetties that are *required* for the object in view we pass to the other one of the heights that are *admissible* without unfavorably affecting the state of the river above. Such unfavorable consequences may be said to assert themselves in two symptoms, viz, declining of cross-sectional areas due to the slacking of currents under the influence of continued restriction below and a loss of tidal range at points above the improvement, and from both these points of view the question will, therefore, have to be discussed.

In regard to the first point the available evidence is very slim. As far as I have been able to find out no comparisons have been made between the status of the upper river as it was at the various stages of the lower improvement and the status of it as shown by earlier coast-survey maps. The Dames Point survey of 1889 seems to have been the only field work which could have formed the basis of such a comparison, but it does not appear to have been utilized for that purpose. The work required for a systematic comparison was commenced by me, but could not be completed in time for this report. The only reliable information available at present is that rendered by the Table No. 1, according to which there exists a tendency to decrease of areas in the region of sections 84 and 85, due, apparently, to the above-mentioned cause. The local claim is made that a similar shoaling tendency exists further up, at Mile Point Bank, and, although this can not be verified at present, the recent survey of that region not having been platted yet, the present situation in regard to the question under discussion seems to be such as to call for a thorough investigation, and, pending that, no further diminishing of the opening by carrying the jetties above mean low water.

Among the evidence bearing on the chances of a loss of tidal range at points above are the surface current observations between the jetties, made according to your instructions and respectfully submitted herewith in diagram No. —.

The result of these observations (which were preëminently for direction) may be summed up as follows:

Flood current.—During southeast winds the surface flood currents come in across the south jetty, but not across the north jetty.

During northeast winds the surface flood currents come in across both jetties.

Ebb current.—During southeast winds there is no discharge across the south jetty, but there is some discharge across the north jetty.

During northeast winds there is considerable discharge across the south jetty. No data are available for the north jetty, but it may be taken for granted that there is no discharge across it.

If, in addition to the evidence of the current observations, the direction of the main channel and the flood channel near and above the shore end of the south jetty is considered, then we arrive at the conclusion that the flood currents in probably all kinds of wind come in across the south jetty in directions on the average parallel to the long shore end of the north jetty, across which latter there is probably little flood flow.

The inferences to be drawn from the current observations therefore are that a heightening of the south jetty has the tendency to shut out the flood current and that it would be useful in training the ebb current and preventing spill during northeasterly winds only, as during southeasterly winds the direction of the ebb currents is now already parallel to the south jetty.

4. Has the tidal range been reduced?—A direct comparison of the former and the present tidal range could be made at Mayport only, where Mr. Daubeney, in 1879, from a series of 260 observations found mean rise and fall at 4.30 feet, which is almost exactly the same figure that has been found from a still greater number of observations made in recent years, as rendered further below in Table No. 1.

At Mayport, therefore, no reduction of range has taken place, but from this fact we can not draw any conclusions for other points farther up. No long and reliable series of observations existing for these upper points, the only possible way to decide the question is by comparing the present ebb and flood volumes with the discharge of the river as gauged by Mr. Daubeney in 1878, before the construction of the jetties was commenced.

For the computation of the ebb and flood volumes by means of tidal observations the following data have to be determined:

1. Time of change of current for flood and for ebb at the point where the discharge is to be found.
2. The state of the river's surface at the time of the two changes of current in order to deduce therefrom the height of the voided prism in its various parts.
3. The area of river surface covered by the tidal prism.
4. The fresh-water flow.

In order to determine the first two items a thorough knowledge of the mean tidal constants is required for the various points on the river. No computation of this kind, based on an extensive series of observations, having been made before, the available observations of former years were carefully scrutinized with a view to utilizing them. It was finally decided to use Mayport as a standard point and to determine its mean low and mean high water from observations made in 1887, 1888, 1889, and 1890, in addition to those made during the present survey, altogether about 350 observations of low and high water each. While the observed heights of the old series thus formed a valuable aid in arriving at a reliable mean, it was found that the observations of time were less accurate. Apart from the confusion of standard time and local time found in some places (which explains the great difference between the times of propagation found now and those found in 1889) there seemed to be minor inaccuracies due probably to the difficulty of keeping the clocks set correctly. It was therefore determined to use for the computation of time for Mayport only the short series of about 100 high and 100 low water observations made during the present survey, in which the time was known to have been kept correctly through frequent comparisons with Jacksonville. The observations at Mayport you have decided to continue and it is quite probable that the final computation of a larger series than is available now will render results slightly different from those submitted herewith.

From Mayport as a standard the lunitidal intervals and the mean high and mean low water readings were deduced by means of simultaneous observations for the mouth, Dames Point, Jacksonville, and Palatka. For the mouth and Dames Point some of the old observations were utilized for this work, but above Dames Point no previous tidal record existed excepting a few observations made at Chaseville and Jacksonville in 1889. The data for Jacksonville and Palatka are therefore deduced from simultaneous observations made for that purpose during the present survey.

The condensed tidal results obtained in the above-described way are rendered in the following table:

TABLE No. 2.—*Tidal data on St. Johns River, Florida.*

Locality.	Distance in statute miles.	Lunitidal interval. High water.	Lunitidal interval. Low water.	Duration of— Rise.	Duration of— Fall.	Reading of— High water.	Reading of— Low water.	Mean rise and fall.
		h. m.	h. m.	h. m.	h. m.	Feet.	Feet.	Feet.
South jetty, outside	....	7 21	13 31	6 15	6 10	4.90	—0.30	5.20
South jetty, inside	0.0	7 21	13 37	6 10	6 16	4.90	—0.10	5.00
Mayport	1.7	7 34	13 56	6 03	6 22	4.65	0.31	4.34
Fulton	6.5	7 57	14 10	6 12	6 13	....	....	....
Dames Point	11.5	8 19	14 29	6 15	6 10	3.77	2.00	1.77
Jacksonville	23.1	9 03	15 08	6 20	6 05	3.22	2.20	1.02
Palatka	87.1	14 42	20 26	6 41	5 44	5.02	3.87	1.15
San Mateo	92.3	15 07	20 52	6 40	5 45	....	....	....
Little Lake George	108.6	17 00	23 00	....	....	....	....	....

NOTE.—The lunitidal intervals for Little Lake George are estimated, no observations at the place (which is believed to be the head of tide) having been made.

On a diagram submitted herewith the mean tidal curves for Mayport, Jacksonville, and Palatka are arranged according to their time after lunar transit. Their intersections with any of the vertical time lines, therefore, show the synchronous state of the river's surface existing at that particular time and as referred to the plane of high water which, in default of any information on the subject, has been assumed as

horizontal from the mouth to the head of tide. From this diagram are deduced the surface lines of the tidal prism at the time of beginning and ending of ebb current at Mayport. (See diagram.) For the determination of the time of change of current (or beginning and end of ebb current) the following data had been available:

In the Report of the Chief of Engineers for 1879, page 787, Mr. Daubeney states "that the ebb current at Mayport commences 2 hours after high-water stand, and ends from 2½ to 3 hours after low-water stand."

From current observations, made 1890, between the jetties, these figures were found at 1 hour 25 minutes and 2 hours 44 minutes, respectively. (Report of Chief of Engineers, 1890, Vol. 2, Pl. IV, accompanying annual survey of St. Johns Bar.)

From surface current observations, made during present survey between the jetties, the time of change of current was found at about 2 hours after high as well as low water stand.

Again, in the Report of 1879, Gen. Gillmore gives the duration of currents at Mayport at 6 hours 45 minutes for the ebb and 5 hours for the flood.

Considering all this evidence, the change of current at Mayport has been assumed to take place 2 hours after high and 2½ hours after low water, which renders a duration of 6 hours 52 minutes for the ebb and 5 hours 33 minutes for the flood current, and the following time as referred to lunar transit:

Beginning of ebb current, 9 hours 34 minutes.

End of ebb current, 16 hours 26 minutes.

For these points of time, then, the elevation of the river's surface has been taken from the diagram of the mean tidal curves and plotted on the diagram showing the heights of tidal prism.

The surface areas of the river were found partly from the map of the survey of 1889, partly from Coast Survey maps, and are rendered in the following table:

TABLE 3.—*Surface areas of St. Johns River.*

	Square feet.
From outer end of jetties to Mayport	51,000,000
From Mayport to St. Johns Bluff	88,000,000
From St. Johns Bluff to Dames Point	247,000,000
From Dames Point to Jacksonville	405,000,000
From Jacksonville to Palatka	3,017,000,000
From Palatka to head of tide	184,000,000
Total	3,992,000,000

In computing the tidal discharge of a river with low and marshy shores from its tidal data, the tendency generally is toward results that are too small on account of the probability that not the entire area of lowlands submerged at high water has been considered. In the case of the St. Johns this difficulty is in a great measure removed by the peculiarity of the propagation of the tidal wave in it. At the time the ebb current commences to run at Mayport it is about high water at Jacksonville and low water at Palatka. About half way between these two places, somewhat above San Patricio, probably, the two lines showing river's surface at beginning and end of Mayport ebb current, therefore, cross each other as shown on the diagram. In other words, the tidal prism voided during a Mayport ebb tide does not extend to the head of tide, but only to a point about 50 miles below it; above that point (San Patricio) the water does not *fall*, but it rises during such ebb tide—that is, the prism above San Patricio is not voided but is filled. During a flood tide at Mayport the same prism is, of course, voided and not filled. This upper volume, therefore, enters negatively into the computation of ebb outflow or flood inflow for any point near the mouth, and the volumes pertaining to the areas of unconsidered submerged lands are therefore also partly positive, partly negative, and may reasonably be supposed to approximately balance themselves.

Incidentally it may be remarked here, that there can be no doubt but what the construction of a dam at San Patricio, preventing the tide from ascending the river any further, would increase the discharge at the mouth to the amount of the above-described prism now extending from San Patricio to head of tide, an increase that would not be less than 500,000,000 cubic feet, or about one-quarter of the present outflow.

We have next to determine the fresh-water flow. The mean annual rainfall at Jacksonville has been found from twenty years' observations to be 4½ feet. Assuming the area of the basin of the St. Johns River at 8,160 square miles, we obtain a mean volume of rainfall per second of 32,460 cubic feet, or when the above duration of ebb and flood currents is considered:

	Cubic feet.
Mean volume of rainfall during ebb flow	802,000,000
Mean volume of rainfall during flood flow	648,000,000

The question, how much of this entire quantity of atmospheric precipitation is evaporated and absorbed and how much of it reaches the sea, can. of course, be answered only approximately. Still we have some guiding points in the matter and are not apt to err to such an extent as to seriously impair the value of our final results for ebb and flood flow.

Mr. Daubeney's difference between ebb and flood volumes renders the coefficient of efflux at about 0.41.

A similar result has been found by me, through the same means, for the mouth of the Savannah River, viz, 0.43, but was at the time already, for various reasons, considered somewhat too great.

From three years daily observations of the river gauge and of rainfall at Augusta, 215 miles from the mouth, I have subsequently determined the coefficient of efflux there at 0.47, and in view of this result for a point in the hilly region of the river the belief is confirmed that the result found for the mouth was too great. If the amount of 1,000 cubic feet per second, which was thought to be the excess, is deducted, then we obtain a coefficient of 0.40, which seems to bear a better proportion to the 0.47 at Augusta.

If it is considered now that about two-thirds of the basin of the Savannah consists of rolling country while the entire basin of the St. Johns is flat, then it becomes evident that the coefficient of efflux for the St. Johns must be smaller than that for the Savannah. This is corroborated by Gen. Gilmore, who holds that 0.25 would be nearer the truth than 0.41.

From all this evidence it is believed that a coefficient of efflux of 0.33 will not be far from the truth; this renders for the fresh-water flow at the mouth:

	Cubic feet.
Fresh-water flow during ebb current	267,000,000
Fresh-water flow during flood current	216,000,000

On the basis of all these data we are now enabled to determine the tidal flow at Mayport.

On account of the meagerness of tidal data for Dames Point the height of tidal prism there has been assumed in these computations greater than it probably is. For uniform surface slopes from Mayport to Jacksonville, as shown on the diagram, the ebb and flood volumes would be about 100,000,000 cubic feet smaller.

Tidal flow at Mayport.

[Computed for mean tidal ranges as given in Table No. 2, and for change of currents 2 hours after high-water and 2½ hours after low-water stand.]

1. EBB FLOW

Locality.	Area.	Height.	Volume.
Prism voided.	*Square feet.*	*Feet.*	*Cubic feet.*
Mayport to Dames Point	335,000,000	1.57	526,000,000
Dames Point to Jacksonville	405,000,000	1.28	518,000,000
Jacksonville to end of voided prism	1,970,000,000	0.47	926,000,000
Volume of prism voided			1,970,000,000
Prism filled.			
Beginning of filled prism to head of tide	1,232	0.45	554,000,000
Consequently, prism voided through Mayport cross section			1,416,000,000
Plus fresh-water flow during ebb			267,000,000
Entire ebb flow at Mayport			1,663,000,000

2. FLOOD FLOW.

	Cubic feet.
Prism filled through Mayport section as above	1,416,000,000
Less fresh-water flow during flood	216,000,000
Entire flood inflow at Mayport	1,200,000,000

Against these figures we have the volumes found in 1878, as follows:

Tidal flow found by gauging the river at Mayport in 1878.

	Cubic feet.
Ebb outflow	1,860,000
Flood inflow	1,181,000

In comparing and weighing these results it must be borne in mind that the beginning of the 1878 gauging work was preceded by a very wet season. For September of that year the Jacksonville record gives the unexampled precipitation of 21 inches; that is more than one-third of the mean annual rainfall. The effect of this has probably extended into the commencement of the survey, November 2d to 4th, the only time when flood current was observed. In this connection General Gillmore expressed himself as follows (Report of 1879, page 781):

There can be no doubt that when the river was gauged for flood the supply of fresh water was in excess of the average amount and diminished the volume of the sea water entering the river.

The ebb current was observed in three series, viz, from November 5 to November 8, from November 23 to November 26, and from December 7 to December 12, and it may be assumed that the means of these have rendered average results. We are, therefore, led to correct Mr. Daubeney's figures by increasing the flood volume sufficiently to render a difference equal to our fresh-water flow for half a lunar day; that is, 483,000,000 cubic feet. This renders:

Volumes of 1878 corrected for fresh-water flow.

	Cubic feet.
Ebb outflow	1,860,000,000
Flood inflow	1,377,000,000

In this form, in which the results of 1878 are probably as near to the truth as may expected from so experienced an observer as Mr. Daubeney, they indicate a decided falling off of the tidal prism since that time.

But in order to weigh the evidence as to the present volumes according to its true value, it should be stated that very slight changes in the assumed time of change of current and in the mean rise and fall at the upper points will cause considerable changes in the volumes computed on the basis of these data. If, for instance, the time of change of current is assumed at 1 hour 43 minutes after high and 2 hours 20 minutes after low-water, then we obtain the following volumes:

Tidal flow at Mayport.

Computed for mean tidal ranges as given in Table No. 2 and for change of current 1 hour 43 minutes after high-water and 2 hours 20 minutes after low-water stand—

	Cubic feet.
Ebb outflow	1,756,000,000
Flood inflow	1,273,000,000

If in addition to this correction mean rise and fall at Palatka is assumed at 1.0 instead, of 1.15, as above, then the following volumes are found:

Tidal flow at Mayport.

Computed for a mean tidal range at Palatka of 1.0, other mean ranges the same as in table No. 2, time of change of current 1 hour 43 minutes after high-water and 2 hours 20 minutes after low-water stand—

	Cubic feet.
Ebb outflow	1,859,000,000
Flood inflow	1,376,000,000

a result agreeing almost exactly with the corrected figures of 1878.

Now, the present observations have extended over too short a time to establish the mean tidal data, on which are based the above computations, with sufficient exactness as to exclude the possibility of errors reaching the indicated limit, and the final conclusion to be drawn from the comparison of the tidal prism and the gauging work of 1878 must, therefore, be limited to the statement that a diminution of the tidal prism of the river is indicated, but not established with certainty.

The attempt to secure additional information by drawing into the scope of the comparison the gauging work of 1889 had to be abandoned, on account of the radical incompatibility of their results with the results of 1878 and those of the present computation. The figures found from the work done in 1889 are rendered in the Report of 1890 in a table facing page 1561, as follows:

Tidal flow at St. Johns Bluff, as found 1889.

	Cubic feet.
Ebb outflow	1,981,000,000
Flood inflow	723,000,000

Tidal flow at Dame's Point, as found 1889.

	Cubic feet.
Ebb outflow	1,970,000,000
Flood inflow	676,000,000

The following figures are rendered by computation assuming change of current at 1 hour 30 minutes after high and 2 hours 20 minutes after low-water stand and mean rise and fall at Palatka at 1 foot.

Tidal flow at St. Johns Bluff as computed from tidal prism.

	Cubic feet.
Ebb outflow	1,563,000,000
Flood inflow	1,080,000,000

Tidal flow at Dames Point, as computed from tidal prism.

	Cubic feet.
Ebb outflow	1,247,000,000
Flood inflow	763,000,000

Although, as stated above, the results of the present computation are considerably swayed by comparatively slight changes in the data on which they are based, and although the data for St. Johns Bluff and Dames Point are approximate only, still, the differences found, at the latter place especially, are too great to be accounted for in this way, and in view of the fact that during the time of the gauging of 1889 and for four months previous to it the rainfall as given by the Jacksonville record was not much in excess of the average, it is difficult to understand the results of this gauging work.

In order to definitely decide the question whether the tidal prism of the river has been reduced since the construction of the jetties, it will be necessary to regauge the river at the Mayport section of 1878, having at the same time during the entire duration of the work careful observations of high and low water made along the entire tidal portion of the river, say at Mayport, Dames Point, Jacksonville, Green Cove Springs, and Palatka. An establishment of one or two self-registering gauges would undoubtedly be of great advantage to the work.

Such a gauging, combined with the tidal results obtained, would not only settle the question at issue at present, but it would also furnish the necessary data to feel, as it were, the river's pulse during the further continuation of the work by means of continued tidal observations, from which, if properly arranged, any decline of range would become apparent at its commencement, almost.

The drift of all available information pointing towards a continuation of the south jetty, and, for the present at least, a cessation of work on the north jetty, it becomes of importance to inquire, as far as possible, into the conditions of flow that will probably be developed alongside of the proposed continuation. A direct solution of the question is not possible, but we can approach it by discussing the conditions existing at the outer end of the south jetty now.

During northeasterly winds, which are the prevailing and, therefore, the more important ones for the channel, the spill during ebb tide over the north jetty is likely to be so insignificant that it may be neglected altogether. The spill over the south jetty, however, is very considerable, as shown by our current observations. Drawing a line at right angles to the main direction of the latter, the length of this line from the end of south jetty to the shore represents about the width of the section of discharge over the top of the jetty, the height of which section of discharge is equal to the mean elevation of surface above mean low water during ebb flow. The length in question is found at about 4,500 feet and the height is about 1½ feet. Furthermore, the low-water cross-sectional area between jetties at their outer end at present is about 23,500 square feet, so that the entire mean area of ebb outflow is found as follows:

	Square feet.
Low-water cross-sectional area between jetties	23,500
Additional area pertaining to ebb outflow, 1½ by 1,600	2,400
Area of outflow over jetty 4,500 by 1½	6,750
Total mean area of ebb outflow	32,650

The ebb discharge at the outer end of south jetty is found at about 2,070,000,000 cubic feet when Palatka range is assumed at 1 foot and at about 1,940,000,000 cubic feet when Palatka range is assumed at 1.15 feet. Adopting the mean of these two figures and a duration of ebb current of 6 hours 53 minutes, we now obtain for the mean velocity between jetties at their outer end

$$V = \frac{2,005,000,000}{32650 \times 24780} = 2.5 \text{ feet per second,}$$

from which, according to relations found at other places, we may deduce a mean bottom velocity at the time of maximum current of about the same amount and a channel bottom velocity at the time of maximum current of about 3 feet.

At the future outer end of the south jetty, with an unprolonged north jetty, not quite as great velocity can be expected; but during northerly winds the difference is not likely to be great, and there will then be channel bottom velocities at the time of maximum current of probably 2¼ feet or even more—more than sufficient to move the fine sand of which the bottom consists.

Summing up, we may state the principal deductions derived from the various matters discussed in this report as follows:

1. The effectiveness of the south jetty, carried no higher than low-water level, to create and maintain a channel is demonstrated by the movements of shoals between jetties as apparent from the comparative cross sections submitted herewith and by the history of the south jetty and its channel as apparent from the diagram. This evidence is corroborated by a discussion of the strength of ebb currents between the jetties and their probable strength along the future continuation of the south jetty.

2. Apparent shoaling tendencies and a possible loss of tidal range above, as indicated by a comparison of former and present flow, seem to be a warning that restriction of the entrance by heightening the jetties should not be carried any further at present. This evidence is corroborated by the observations of direction of current made between the jetties.

The lack of positiveness in a great part of the discussion submitted herewith and the conclusions arrived at is partly due to the previous absence of information in regard to the upper river and partly to the shortness of time in which this and other information had to be supplied. The latter circumstance has also prevented the successful observation of sand movements during ebb and flood desired by you in your instructions.

I finally desire to express my appreciation of the efficient assistance rendered by Messrs. F. W. Bruce, L. S. Mattair, and P. B. Bird. Mr. Bruce assisted me during the beginning of the survey, before Mr. Bird joined me, and has continued to render most valuable aid during the entire duration of the survey whenever called upon.

Submitting the above, I am, major, very respectfully, your obedient servant,

E. A. GIESELER,
United States Assistant Engineer.

Maj. J. C. MALLERY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commerce of St. Johns River, Florida, during the year ending December 31, 1891.

Articles.	Quantity.	Gross tonnage.	Estimated value.
Cotton .... bales..	810	162	$81,000
Fertilizers .... tons..	14,000	14,000	420,000
Fish and oysters .... barrels..	200	35	1,000
Fruits .... boxes..	12,405	546	18,608
Bananas .... bunches..	12,000	450	12,000
Oranges .... boxes..	416,100	16,644	832,200
Hides .... tons..	30	30	4,000
Lumber:			
Rough .... feet..	45,000,000	112,500	270,000
Sawed .... feet, B. M..	53,276,090	133,190	627,323
Merchandise .... tons..	200,000	200,000	10,000,000
Ship stores .... barrels..	700	158	7,175
Vegetables .... boxes..	5,310	212	10,620
Shingles .... number..	24,000,000	960	74,000
Railroad ties .... do...	186,000	13,950	46,500
Phosphate .... tons..	2,380	2,380	12,800
Coal .... do...	12,000	12,000	60,000
Brick .... number..	600,000	1,500	6,000
Ice .... tons..	1,200	1,200	2,400
Lime .... barrels..	13,000	1,300	13,000
Total	....	511,217	12,498,626

Vessels.	Character.	No.	Average tonnage.	Average draft.
				Feet.
Steamers	Merchant	324	1,895.75	$11\frac{5}{12}$
Sailing	......do	329	258.61	11

A new line of ocean steamers, the Merchants', has been established to New York, and two other lines of fruit steamers, from England, are awaiting the improvement of the river to a sufficient depth to enable them to reach Jacksonville.

Passengers, 13,000, at $234,000.

Estimated percentage of total trade of neighborhood carried by water, one-fourth.

Probable increase of trade were the improvement completed, 300 per cent.

The above statement covers the shipping and merchandise that crosses the bar at the mouth of the St. Johns River to and from Jacksonville only.

CHAS. H. SMITH,
Secretary Board of Trade.

O 2.

IMPROVEMENT OF OCKLAWAHA RIVER, FLORIDA.

The Ocklawaha River has its source in Lake Apopka, Central Florida, flows slightly west of north for about 104 miles, measured along the axis of the channel, then almost due east for 21 miles farther, when it unites with the St. Johns River. The Ocklawaha River is the principal outlet of a number of large lakes, whose aggregate area is about 175 square miles.

The only important tributary of the Ocklawaha River is the Silver Spring Run, which is 6 miles long and has an average width of about 50 feet and a least depth along the axis of the channel of about 9 feet. Being the outlet of the famous Silver Spring, its volume of discharge varies but little.

From Lake Griffin down for a distance of about 28 miles the river flows through a wide savanna, submerged about 1 foot under water and covered with a dense growth of saw grass. On this reach the river averages from 30 to 40 feet in width and has a least channel depth of about 5 feet. The current is very sluggish.

The impediments to navigation on this portion of the river are the numerous bends, the narrow channel, floating islands, and eelgrass.

From the savanna to the mouth, a distance of about 58 miles, the banks are covered with a dense growth of cypress and other timber.

On this reach the river averages from 60 to 70 feet in width and the least channel depth is 4 feet. The average velocity of the current is considerably greater than on the upper river, being about 1.3 feet per second.

The principal obstructions to navigation are snags and overhanging trees.

PROJECT OF IMPROVEMENT.

The approved project is to clear the channel between Lake Griffin and the mouth by removing the snags and the worst overhanging trees, and by moving the floating islands out of the channel and staking them in place by piles.

OPERATIONS PRIOR TO JUNE 30, 1891.

By act of Congress approved September 19, 1890, an appropriation of $10,000 was made for "improving Ocklawaha River, Florida, to Leesburg, on Lake Griffin."

A survey of the entire river between Lake Griffin and the mouth was made. The project was prepared and submitted. The work recommended at that time was estimated to cost $7,500.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

With the approval of the Chief of Engineers it was decided to do the work by hired labor; accordingly the derrick scow, which had been in use on the jetties at the mouth of the St. Johns River, was equipped with quarters and such additional machinery and tools as would be required, and work was begun on the river January 12 and continued until June 30, when the appropriation was exhausted. The work has resulted in clearing the river of its worst obstructions from the mouth to the prairie, a distance of 60 miles. On account of the remarkably low stage of the river the boat could not go above the prairie, and no work was done on the floating islands.

One thousand two hundred and eighty-four snags over 2 feet, 1,689 from 8 inches to 2 feet, and 908 under 8 inches in diameter were removed; 91 overhanging trees over 2 feet, 376 from 8 inches to 2 feet, and 238 under 8 inches in diameter were removed; 84 trees were trimmed; making a total of 3,881 snags and 705 overhanging trees removed, and 84 trees trimmed.

The river has been unprecedentedly low,—3 feet below its level when the survey was made, which at that time, from the best information available, was believed to be the ordinary low-water stage. Only 608 snags were counted during the survey.

At present the river is fairly navigable as far as the prairie. Above that point there are a few shoals and the floating islands. The oranges and vegetables are usually shipped when the water is at its low stage, and the shoals form serious obstructions. It is believed that the channel can not be kept clear of the floating islands unless a row of piles connected by a waling strip is constructed on each side. In view of fact that the railroads are practically inaccessible to a large number of the residents of this portion of the river and that the improvement of the river as far as Leesburg would enable the orange and vegetable growers in the vicinity of Lake Griffin to ship their produce by water to the St. Johns River, it is recommended that the improvement be continued to Lake Griffin. This can be done at an estimated cost of $15,000, with an annual outlay of $1,000 for some years to maintain the clear channel.

The Ocklawaha River is in the collection district of St. Johns. The nearest lighthouse is the St. Augustine Light. The nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1891, balance unexpended	$7,544.32
June 30, 1892, amount expended during fiscal year	6,320.01
July 1, 1892, balance unexpended	1,224.31
July 1, 1892, outstanding liabilities	949.14
July 1, 1892, balance available	275.17
Amount appropriated by act approved July 13, 1892	1,000.00
Amount available for fiscal year ending June 30, 1893	1,275.17
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commerce of Ocklawaha River, Florida, during the year ending December 31, 1891.

Articles.	Quantity.	Gross tonnage.	Estimat value
Cotton ....bales..	255	72½	$16,065
Fertilizers ....tons..	120	120	12,000
Fruits ....boxes..	57,219	3,380	105,000
Grain ....tons..	200	200	17,000
Hides ....bales..	40	1	1,600
Honey, sirup, etc ....tons..	13½	13½	7,200
Lumber:			
Rough ....feet..	5,000,000	50,000	35,000
Sawed ....feet, B. M..	85,000	1,150	8,500
Merchandise ....tons..	913	913	200,000
Vegetables ....boxes..	100	4	100
Total	....	55,854	402,465

Percentage of trade of neighborhood carried by water (estimated): All.
Probable increase of trade were the improvement completed: 150 per cent.
Following is a statement of the business on the lakes at the upper end of the Ocklawaha River for the year 1891:

Articles.	Quantity	Gross tonnage.	Estimated value.
Fertilizers ....tons..	400	400	$12,000
Fish and oysters ....barrels..	5	1	20
Fruits ....boxes..	106,000	4,240	156,000
Grain ....tons..	200	200	17,000
Hides ....do...	5	5	1,000
Honey, sirup, etc ....do...	1	1	400
Lumber:			
Rough ....feet..	50,000	100	5,000
Sawed ....feet, B. M..	1,000,000	2,000	25,000
Merchandise ....tons..	10,000	10,000	800,000
Ship stores ....barrels..	10	1	70
Vegetables ....boxes..	25,000	1,250	25,000
Total	....	18,198	1,041,490

Percentage of trade of neighborhood carried by water (estimated): 50 per cent.
Probable increase of trade were the improvement completed: 150 per cent.
The following steamers are engaged in the trade of the Ocklawaha River:

Name.	Character.	Tonnage.	Draft.
			Feet.
Eureka	Steamer	67	2½
Okeehumpkee	....do	65	4½
Astatula	....do	55	4
Osceola	....do	60	4
Wahoo	....do	35	1½
Elizabeth	....do	4	3½
Sophie Howard	....do	10	3

Number of passengers carried during the year, 5,380.
The following steamers are engaged in the navigation of lakes Griffin, Harris, Eustis, and Dora:

Name.	Character.	Tonnage.	Draft.
			Feet.
Gazelle	Steamer	16	2½
J. A. Lane	....do	30	2½
Helen Denham	....do	32	2½

Number of passengers carried during the year, 1,500.

O 3.

IMPROVING VOLUSIA BAR, FLORIDA.

Volusia Bar is located at the south end or head of Lake George, about 162 miles by river from the mouth of St. Johns River, at the point where the waters of the river flow into the lake.

An examination of Volusia Bar with a view to its improvement was made in March, 1879. A report thereon, dated July 16, 1879, with plan of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879.

This was modified as reported in the Annual Reports of the Chief of Engineers for 1882 and 1883, Appendixes J 11 and L 14, respectively.

Before its improvement the channel over the bar was very crooked, and had a least depth varying from 3½ to 4¼ feet.

APPROVED PROJECT.

To establish and maintain a channel 6 feet deep across the bar by the increased velocity of flow produced by two converging jetties of brush and stone, assisted by dredging, if necessary, and to define and protect the channel thus formed by rows of fender piles.

In 1887 this project was modified to limit the depth to the 5 feet already attained, as that depth is sufficient for the steamers navigating the Upper St. John's River, and is as great as can be carried over the bars between Lake Monroe and Lake George.

Operations for improving Volusia Bar, Florida, have been carried on at intervals since December, 1880, under the following appropriations, viz:

By act approved—	
June 14, 1880	$5,000
March 3, 1881	5,500
By act passed August 2, 1882	5,000
By act approved—	
July 5, 1884	2,000
August 5, 1886	7,500
By act of August 11, 1888	500
By act approved September 19, 1890	500
Total	26,000

OPERATIONS PRIOR TO JUNE 30, 1891.

The total amount expended up to June 30, 1891, including liabilities then outstanding, was $25,495.87. Two jetties had been built, starting from opposite sides of the river bank at the south edge of the lake and converging until on the bar the clear channel way between them was 230 feet wide. The east jetty is 3,400 feet long, and is built to the level of mean low water for 2,930 feet from the shore. The west jetty is 2,200 feet long, of which a length of 1,940 has its crest at the level of mean low water. Two rows of firmly set piles, provided with waling strips, confine boats to a 100-foot channel across the crest of the bar. In 1887 the depth attained was reported to be ample for the existing commerce.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Under the appropriation of September 19, 1890, 97.02 cubic yards of stone were placed on the east jetty, distributed between points 35 feet and 290 feet, respectively, from the outer end, forming a crest about

2.5 feet wide and at an elevation of one-half foot below mean low water. An examination of the work was made in July, 1891.

WORK REQUIRED.

The St. Johns River above Lake George is a silt-bearing stream, having eroding banks, pools, and shoals, and is subject to marked fluctuations of level. Lake George forms a settling basin and receives an annual deposit from the materials eroded between lakes George and Monroe, a distance of 45 miles. The greater portion of this material is deposited at the head of the lake, where the river currents lose velocity in entering the broader expanse, and there forms and maintains Volusia Bar. It is evident that any increase of depth produced by contraction and scour in a bar of this character will simply push the deposit farther out into the still water. If the depth of the lake where the new deposit is formed were great, the improvement of the channel by unassisted jetties might have some permanence.

Lake George is very shoal. In 1887 the least channel depth was reported to be 5 feet; the 6, 7, and 8 foot contours of the bottom were 420,780, and 1,440 feet, respectively. From the ends of the jetties and at the distance of 3,400 feet beyond the jetties a maximum depth of 9.6 feet only was found. In 1891 the least channel depth is 4.6 feet and the 6, 7, and 8 foot contours 375, 480, and 1,175 feet, respectively, from the ends of the jetties.

Commerce has been greatly hampered by boats grounding on the bar during the past low-water season. Further improvement of the bar is required. Only temporary relief can be obtained by an extension of the jetties.

The best and surest method to adopt will be to deepen the channel by dredging from time to time as may be needed.

From past experience it would seem that the annual deposit on the bar is about 500 cubic yards. If there were any plant available this could be removed with an annual expenditure of $500. As there is no dredging plant available at present, in this vicinity, the cost of the work by contract would be more than double, if indeed any bids could be obtained. As work is also urgently needed on the Upper St. Johns River, as reported in letter dated January 26, 1891, printed in House Ex. Doc. No. 240, Fifty-first Congress, second session, and for which the sum of $4,930 is now available, it would be a great advantage for the United States to own a properly equipped snag and dredge boat for operations on the entire river. Such a boat could be obtained for $15,000. She could be operated at a cost not exceeding $800 per month.

During the past winter the commerce of the upper river was greatly increased, and the indications point to a further increase of both freight and passenger traffic if the river can be navigated without the vexatious delays caused by the grounding of the boats.

This work is in the collection district of St. Johns. Jacksonville is the nearest port of entry. Nearest light-house is Volusia Bar Light. Nearest fort is Fort Marion.

Money statement.

July 1, 1891, balance unexpended	$504.13
June 30, 1892, amount expended during fiscal year	394.04
July 1, 1892, balance unexpended	110.09
Amount appropriated by act approved July 13, 1892	1,000.00
Amount available for fiscal year ending June 30, 1893	1,110.09

Amount (estimated) required annually for maintenance of existing project	$1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commerce af Volusia Bar, Florida, durinj the year ending December 31, 1891.

[Furnished by Maj. J. A. Leslie, superintendent Clyde Steamship Line, Jacksonville, Fla.]

Articles.	Gross tonnage.	Estimated. value.
Fertilizers	4,623	$92,460.00
Fish and oysters	83	4,155.00
Fruits	5,937	445,326.00
Grain	4,308	99,632.50
Merchandise	10,036	3,010,800.00
Vegetables	387	19,364.00
Hay	1,409	28,180.00
Total	26,783	3,699,917.50

Vessels.	Character.	Draft of water.
		Feet.
City of Jacksonville	Passenger steamer	4½
Fredrick De Barry	do	4¼
Everglade	Freight steamer	4½
Welaka	do	4½

O 4.

IMPROVEMENT OF ST. AUGUSTINE HARBOR, FLORIDA.

St. Augustine Harbor lies on the east coast of Florida, about 47 miles south of the St. John's River. It is formed by the junction of two rivers, or rather salt-water lagoons, the Matanzas and Tolomato rivers, which run parallel to the coast and there unite to break through the line of sand hills into the sea. The total length of the Tolomato River is about 20 miles and of that part of the Matanzas which receives and discharges across the St. Augustine Bar 12 miles. The San Sebastian River, another lagoon, almost surrounds St. Augustine, and opens into the Matanzas River about 3 miles from its mouth. These lagoons vary in depth from 20 to 30 feet for several miles from the mouth and in width from 300 to 500 yards. They form large tidal basins, filled and emptied through the channels across the bar. The rise of tide at St. Augustine varies from 4 to 6 feet, and the currents generated have maintained two or more channels across the bar, with a least depth of from 6 to 9 feet at low water. The positions of these channels are continually shifting between the south end of the mainland east of the Tolomato River (North Beach or North Point), and the cape on Anastasia Island, 2¾ miles to the south. The harbor forms an excellent sheltered anchorage, but the shifting nature of the bar and the shallow water on its crest have presented so many difficulties to mariners that the commerce of the port has been greatly hampered. It is limited practically to the necessary supplies for St. Augustine.

The following appropriations have been made for this harbor:

Act of August 11, 1888	$35,000
Act approved September 19, 1890	20,000
Total	55,000

PROJECT.

The approved project is to protect the shores from erosion by the construction of groins of concrete and riprap on brush foundation mattresses.

OPERATIONS PRIOR TO JUNE 30, 1891.

With the appropriation of $35,000 made in the act of 1888, three groins were built: No. 1, on Anastasia Island, near the northern boundary of the United States light-house reservation; No. 2, on North Beach, at the point; No. 3, on North Beach, about 2,000 feet from the point.

These groins all consist, essentially, of a foundation of brush fascines, covered with riprap and capped with concrete blocks which are 2 feet wide on top and have side slopes of 1 on 2. (For detailed description of dimensions and methods, see Appendix P 3, Report of the Chief of Engineers, 1890.)

With the appropriation of $20,000 made in act of September 19, 1890, Groin No. 2 was extended seaward, and two new groins were built: No. 4, on Anastasia Island, about 2,200 feet northwest of Groin No. 1, and No. 5, on North Beach, between Groin No. 2 and Groin No. 3. (For detailed description of dimensions and methods, see Appendix O 4, Report of the Chief of Engineers, 1891.)

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

During the year a close watch was kept of the condition of the groins with a view of using the small amount still available in making repairs whenever necessary. During December it was noticed that it would be necessary to protect the beach from further erosion in the vicinity of Groin No. 4. Accordingly the construction of a sheet-pile wing dam was begun in January and continued at intervals until May.

This dam is 327 feet long and is built near the ordinary high-water mark at the side of the groin and extends along the beach toward the south. It is constructed of a double row of sheet piles well braced from the rear. The back is filled in with mud and sand, and the front is protected with fascines staked in place and weighted with rock. The desired result has been produced and the sand is filling in in front of the wing dam.

The outer block of concrete on Groin No. 4 having been made of material that had been mixed several days before using, was destroyed by the waves. This was replaced in March.

CONDITION OF THE GROINS.

All of the groins are in excellent condition with the exception of Groin No. 2. The repairs to the cracks in the concrete of this groin, as detailed on page 1633, Report of Chief of Engineers, 1891, have proved ineffective, and considerable of the material used in making the repairs has washed out. The safety of the groin does not appear, however, to be endangered in consequence.

EFFECT OF THE GROINS.

A survey made in April, 1892, shows the effect of the groins to be as follows:

At Groin No. 1, Anastasia Island, both the high and low water lines

have advanced slightly. The high-water line has advanced 40 feet and the low-water line about 25 feet.

At Groin No. 4, Anastasia Island, the high-water line has been pushed back a few feet, while the low-water line has advanced about 50 feet.

From a point about 1,000 feet from Groin No. 1 to near Groin No. 4 the beach has been slightly eroded.

At Groin No. 2, North Beach, the high-water line on the east side has advanced 100 feet, while on the west side, where the most marked erosion of any portion of the beach has taken place, the extreme high-water line has receded nearly 100 feet, while the ordinary high-water line has receded very slightly. The low-water line on both sides has advanced about 50 feet.

All along the beach in the vicinities of Groins Nos. 3 and 5, North Beach, the shore lines have continued to advance. The high-water line has advanced on an average 200 feet and the low-water line 100 feet.

A map, showing the condition of that portion of the harbor affected by the groins, accompanies this report.

St. Augustine is in the collection district of St. Augustine, which is the nearest port of entry. The nearest fort is Fort Marion. The St. Augustine Light is the nearest light-house.

Money statement.

July 1, 1891, balance unexpended	$4,112.12
June 30, 1892, amount expended during fiscal year	2,832.52
July 1, 1892, balance unexpended	1,279.60
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	11,279.60

COMMERCIAL STATISTICS.

Commerce of St. Augustine, Fla., for the year ending December 31, 1891.

[Furnished by Mr. Henry A. Barling, jr.]

Articles.		Quantity.	Estimated value.	Gross tonnage.
Fertilizers	tons	50	$1,500	50
Fish and oysters	barrels	3,000	5,000	450
Fruits, oranges	boxes	3,000	4,500	90
Grain	bushels	72,000	34,000	2,160
Hay	bales	24,000	24,000	1,200
Honey, sirup, etc	gallons	4,500	1,350	34
Lumber, sawed	feet, B. M.	1,500,000	17,500	3,000
Merchandise	tons	15,300	765,000	15,300
Vegetables	barrels	2,000	10,000	200
Total			862,850	22,484

Vessels.	Character.	Capacity.	Average draft.
		Tons.	*Feet.*
City of St. Augustine	Steamer	720	10½
Schooners (2)	Sail	200	10
Do	do	300	9½

Passengers, none.

Estimated percentage of total trade of neighborhood carried by water, 25.

O 5.

IMPROVEMENT OF NORTHWEST ENTRANCE, KEY WEST HARBOR, FLORIDA.

The Florida Keys consist of a chain of rock and sand islands extending southwesterly from Cape Florida for nearly 200 miles. They are connected by extensive sand flats underlaid by rock, a soft, oölitic limestone, from which the sand is almost entirely formed.

This chain is a barrier for all shipping from the Atlantic to the Gulf (eastern and middle) ports, and the straits between it and the West India Islands form a passage justly dreaded by mariners. This barrier is crossed by four navigable channels, one between the Dry Tortugas, at the western extremity of the chain, and Rebecca Shoals; one east of Rebecca Shoals; the third (the Boca Grande Channel) 28 miles further east, and the fourth (the northwest channel from Key West Harbor) immediately west of Key West, 85 miles east from the Dry Tortugas. It is this easterly position, combined with the good harbor of Key West at its extremity, which gives this channel its importance. It is used by vessels en route between the Atlantic and Gulf ports which do not draw more than 10½ feet of water, the depth available on the bar which now obstructs its northern end. An estimated average daily tonnage of 2,500 tons passes through it. In rough weather the available depth is still more reduced, and vessels of more than 8 feet draft are compelled to pass through one of the channels to the westward.

The necessity for the improvement of the northwest entrance was first brought to the notice of Congress in 1868, and an examination of the bar was ordered. This was made by Lieut. (now Maj.) W. R. Livermore, Corps of Engineers, under the direction of Col. J. H. Simpson, Corps of Engineers. A project was submitted for opening a dredged channel across the bar 300 feet wide, 18 feet deep at mean low water, and 9,000 feet long, at an estimated cost of $217,272.

Nothing more seems to have been done at that time.

In 1881 another examination of the harbor was ordered by Congress. This was made by Thomas L. Harrison, assistant engineer, under the direction of Capt. (now Maj.) A. N. Damrell, Corps of Engineers, as reported on page 1314, Report of the Chief of Engineers, 1882. Maj. Damrell submitted a project for dredging a cut 300 feet wide and 17 feet deep at mean low water at an estimated cost of $140,000. In 1882 Congress appropriated $25,000 for work under this project. With this a cut 60 feet wide and 15 feet deep at mean low water was made across the bar in 1883, but it was soon obliterated and no useful result was obtained. In 1886 an appropriation of $2,500 was made for the examination and survey of the bar. The survey was made in the fall and winter of 1886–'87. In 1888 a further appropriation of $25,000 was made for the improvement of the harbor, subject to the recommendation of a Board of Engineers. A preliminary report was submitted January 31, 1889, and further data having been obtained, in November, 1889, the Board submitted a final report recommending that the improvement of the entrance be begun by the immediate construction of a jetty along its northeastern side.

OPERATIONS PRIOR TO JUNE 30, 1891.

In the act approved September 19, 1890, $40,000 were appropriated for the work. Proposals were opened, after due advertisement, Novem-

ber 29, and a contract was made with Mr. R. G. Ross for delivering stone and constructing the jetty for $1.90 per cubic yard of stone in place. Work under the contract was to be started February 28 and finished July 28, 1891. Owing to the sickness of the contractor and other causes the quarrying of rock was not begun until May. The first stone was deposited in the jetty on June 16. Up to the close of the month 1,160.3 cubic yards had been delivered.

The estimated cost of the jetty is $500,000.

Nine thousand and eighty-seven dollars and sixty-seven cents were expended on the present project up to the close of the fiscal year ending June 30, 1891.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

Operations were continued under the contract with Mr. R. G. Ross until May 12, when the contract was completed. A total of 26,821.9 cubic yards of stone were placed in the jetty during the fiscal year, which, together with 1,160.3 cubic yards placed previously, makes a total of 27,982.2 cubic yards now in the jetty.

For a length of 60 feet in the vicinity of Iron Station (the site of current station No. 10, survey of 1889) the jetty has been built up to within 1 foot of mean low water; to a point 2,190 feet inside of Iron Station it has been built up to within 2 feet of mean low water; from thence to a point 3,070 feet inside of Iron Station to within 5 feet of mean low water, and from thence to a point 4,530 feet from Iron Station to an elevation varying from 3 to 4 feet below mean low water. From thence to a point 5,365 feet inside of Iron Station or the inner end of the jetty only one layer of stone, about 3 feet thick, has been placed, having a depth over it at mean low water of from 6 to 8 feet.

From the Iron Station to a point 840 feet outside of the same, the jetty has been built up to within 2 feet of mean low water; from thence to the outer end of the jetty, 1,523 feet from Iron Station, only 1 layer of stone, about 3 feet thick, has been placed, having over it a depth of from 7 to 10 feet at mean low water. The average width of the base of the jetty was 25 feet and of the crest 10 feet.

The crest of all of the higher portions of the jetty has been lowered by the force of the waves.

PRESENT CONDITION OF THE JETTY.

Along that portion of the jetty inside of Iron Station which was built up to within 2 feet of mean low water the crest width was made about 5 feet. This has all been washed down about 3 feet, the depth over it now averaging 5 feet.

It is believed the stone used is not heavy enough to withstand the force of the waves if placed above the level of 3 feet below mean low-water, even with a very wide crest. Stones weighing as much as 1,600 pounds were displaced at the Iron Station. Very little scour has taken place along the sides of the jetty and little or no settlement of the jetty is manifested.

EFFECT OF THE JETTY.

In regard to the effect of the jetty it can be said that the channel across the bar is in a better condition now than shown by any previous survey. There is an available channel depth of 12.5 feet. There has also been a deepening of the shoalest portions of the flat lying between the Iron Station and the Black Beacon. There now exists over this flat a channel having a least width of 400 feet and a least mid-channel

depth of 11 feet. This latter deepening has evidently been caused by the jetty, but whether the deepening in the main channel is merely temporary or not remains for a further lapse of time to determine.

I would invite attention to the recommendation previously made that the entire amount of money required for the completion of this project be made available for continuous and rapid work. Under small appropriations changes are likely to occur in the condition of the bar highly detrimental to the progress of the improvement, materially increasing the cost of the work and rendering its success problematic.

Complaint having been made by the commanding officer of the United States ship *Philadelphia* of an obstruction in the main ship channel, in the vicinity of the triangle buoys, caused by what are known as the Pinnacle Rocks, as directed by Department indorsement of May 23, 1892, an examination of these rocks was made on June 11 and 14. The rocks were found to be very irregular in shape, in one instance rising out of a depth of 35 feet to within 21 feet of the surface at mean low water. They are included within an area of about 900 square feet and have depths over them varying from 30 to 21 feet at mean low water. It is thought that they can be removed to a depth of 30 feet by surface blasting and dragging, permitting the débris to fall into the deep water surrounding them, at an estimated cost of $1,000.

The harbor at Key West is in the collection district of Key West, Fla., which is the nearest port of entry. Nearest light-house is the Northwest Passage Light. Nearest fort is Fort Taylor, Fla.

Money statement.

July 1, 1891, balance unexpended	$55,912.33
June 30, 1892, amount expended during fiscal year	55,793.73
July 1, 1892, balance unexpended	118.60
July 1, 1892, outstanding liabilities	25.00
July 1, 1892, balance available	93.60
Amount appropriated by act approved July 13, 1882	75,000.00
Amount available for fiscal year ending June 30, 1893	75,093.60
Amount (estimated) required for completion of existing project	385,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	385,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commerce of harbor at Key West, Fla., for the year ending December 31, 1891.

Name of article.	Quantity.	Estimated value.
Fish and oysters ... barrels	6,000	$42,000
Fruits ... boxes	5,000	4,300
Bananas ... bunches	58,000	58,000
Fruits ... crates	15,000	75,049
Grain ... bushels	167,374	113,775
Hides ... number	12,000	15,000
Honey, sirup, etc ... gallons	793	400
Lumber, sawed ... feet, B. M.	10,000,000	200,000
Merchandise ... tons	800,000	8,000,000
Ship stores ... barrels	8,000	50,000
Vegetables ... boxes	300,000	300,000
Leaf tobacco ... bales	13,376	178,000
Total		9,036,524

Commerce of harbor at Key West, Fla., etc.—Continued.

Vessels.	Character.	Gross tonnage.	Average draft.
			Feet.
568	Steamers	620,000	12
664	Sailing	94,600	7

Passengers: 40,396 arrived and departed.
Estimated precentage of total trade of neighborhood carried by water, 95.
Probable increase of trade were the improvement completed, 100 per cent.
Statistics furnished by Mr. George Phillips, of Key West, Fla.

O 6.

IMPROVEMENT OF CALOOSAHATCHEE RIVER, FLORIDA.

The Caloosahatchee River rises in the saw-grass region west of Lake Okeechobee, and flows west into San Carlos Bay. Between the mouth and Fort Thompson, 22 miles west of Lake Okeechobee, the river banks are generally high and the country bordering the river is covered with a dense growth of large trees, principally pines, palmettos, and oaks. East of Fort Thompson the low saw-grass region begins. The entire river valley as far down as Alva, about 20 miles by river below Fort Thompson, is more or less subject to overflow by the water coming from the Okeechobee Basin. For 21 miles from its mouth the river is broad and has a channel depth of from 6 to 20 feet, with the characteristics of an estuary. This portion of the river is obstructed by oyster bars. Great beds of snags obstructed the upper river. From Alva down the country is being settled for the culture of sugar cane, pineapples, cocoanuts, oranges, limes, and lemons. Fine cattle ranges exist along the upper river.

Fort Myers, a depot for supplies during the Seminole war, is a thriving town 17 miles from the mouth.

Under the laws of the State of Florida the Atlantic and Gulf Coast Canal and Okeechobee Land Company is engaged in draining the Okeechobee Basin, having authority from the State to cut canals and use the natural waterways for that purpose. A canal with a minimum cross-section of 22 feet by 5 feet has been opened from Lake Okeechobee to the head waters of the Caloosahatchee River, and through them as far as the western end of Lake Flirt. A rocky ledge at Fort Thompson has been removed and four cut-offs have been made across the worst bends below Fort Thompson. These works were not intended for the benefit of navigation, but they have incidentally opened a water route about 300 miles long from the Gulf of Mexico to the interior of Florida, via San Carlos Bay, the Caloosahatchee River, Lake Okeechobee, the Kissimmee River, and Lake Kissimmee, Cypress, and Tohopekaliga. Steamers now pass over the route at irregular intervals.

An examination of the river, with a view to its improvement, was made in March and April, 1879. A report thereon, dated August 27, 1879, with a plan of improvement, is printed as Appendix J 17, Report of the Chief of Engineers for 1879.

The project adopted in 1882 called for deepening the channel, by dredging, from the mouth to Fort Myers, so as to give a depth of 7 feet at mean low water for a width of 100 feet. In 1886 and 1888 this

project was modified so as to include the improvement of the upper river as far as Fort Thompson by the removal of snags and overhanging trees and by deepening the channel near Beautiful Islands.

OPERATIONS PRIOR TO JUNE 30, 1891.

Operations were carried on under the following appropriations:

Act of—	
1882	$5,000
1884	5,000
1886	4,000
1888	10,000
1890	3,600
Total	27,600

In 1885 the 7-foot channel through the lower river was reported completed. In 1886–'87 the operations were confined to clearing snags and overhanging trees from the river between Forts Denaud and Thompson and in making an instrumental survey of the entire river. This survey showed the existence of a practicable channel 6 feet deep and at least 100 feet wide from the mouth to Fort Myers. It also showed that excepting near the Beautiful Islands the channel has sufficient depth and width to permit boats of 4 feet draft to ascend the river as high as Fort Thompson. The upper river was, however, badly obstructed by snags and overhanging trees, only a short reach, 4½ miles long, having been cleared by the work during May and June, 1887.

Before improvement the lower part of the river was so obstructed by oyster bars that the available channel depth was only about 5½ feet. About 17 miles from the mouth the river loses the characteristics of an estuary, and there are numerous islands and a broad shoal. At the present time the river has been improved so that the navigable channel depth between the mouth and Fort Myers is about 6 feet, and between Fort Myers and Fort Thompson it is 4 feet.

A dike or training wall alongside the cut through Beautiful Island Shoals has been built. It consists of a row of piles in juxtaposition, driven to hard bottom, with a light waling strip on each side. A layer of brush 4 feet wide is placed at the foot of the piles and held down by stakes and by a layer of shell and stone. Upon this was deposited the material dredged from the cut. The channels through the oyster bars have been marked with stakes. For details of the work see Annual Report of the Chief of Engineers for 1891, pages 1644 and 1645.

There were no operations during the fiscal year ending June 30, 1892. All of the work of improvement contemplated has been completed, though it is believed that the dike at Beautiful Islands is not long enough to afford complete protection to the dredged cut at that shoal.

The river can be kept clear at an annual expenditure of $1,000.

Caloosahatchee River is in the collection district of Key West, which is the nearest port of entry; nearest light-house is Sanibel Island Light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1891, balance unexpended	$146.61
August 10, amount refunded by land-grant railroad	3.63
	150.24
June 30, 1892, amount expended during fiscal year	127.65
July 1, 1892, balance unexpended	22.59
Amount appropriated by act approved July 13, 1892	1,000.00
Amount available for fiscal year ending June 30, 1893	1,022.59

Amount (estimated) required for maintenance of existing project	$1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

O 7.

IMPROVEMENT OF CHANNEL OF CHARLOTTE HARBOR AND PEASE CREEK, FLORIDA.

Charlotte Harbor lies 74 miles south of Tampa Bay, and offers the most southerly deep-water harbor on the west coast of Florida. It is the northern division of the broad expanse of generally shallow water included between Gasparilla, Lacosta, Captiva, and Sanibel islands and the mainland, and of which San Carlos Bay forms the southern division. A projection from the mainland, ending in Cape Haze, gives Charlotte Harbor an angular shape, with arms of nearly equal length, starting from the gulf and running nearly east and then north. The width of the bay is about 5½ miles. The total length along the middle line is 22 miles. The total area is 111 square miles. The general depth is from 5 to 15 feet, with deeper water in places along the middle line. The entrance, Boca Grande Pass, is straight and stable in position and depth, with a least channel depth of 19 feet at mean low water. Within the entrance there is an anchorage having an area of 580 acres and a mean low-water depth of 18 feet and over. Between this anchorage and Pease Creek Entrance, at the northeastern extremity of the bay, there is an available channel depth of 15 feet at mean low water, excepting on the shoals south of Cape Haze, where the available channel depth is only 9 feet. Pease Creek is described on page 1600, volume 2, Report of the Chief of Engineers, 1890. The portion included in the improvement of Charlotte Harbor extends from the entrance to the wharves at Punta Gorda, a distance of 1¾ miles. Pease Creek is here quite broad and is really an estuary. It has an available channel depth of 10 feet. The tidal range of the bay and creek varies from 1.9 feet at Gasparilla Island to 1.6 feet at Punta Gorda, but it is subject to great variations, according to the strength and direction of the wind.

An appropriation of $35,000 was made in the act approved September 19, 1890, for "improving, dredging, and deepening the channel of Charlotte Harbor and Pease Creek, Florida, to the pier at Punta Gorda, the terminus of the Florida Southern Railroad."

OPERATIONS PRIOR TO JUNE 30, 1891.

A survey of the bar at the entrance and those portions of the bay and creek within the limits named in the bill which have an available depth less than 15 feet at mean low water was made in November and December, 1890, and January, 1891, by a party under the charge of Mr. J. H. Bacon, assistant engineer. A copy of his report is printed on page 1648 of the Report of the Chief of Engineers for 1891. It was then thought that the greatest advantage to the commercial interests of the harbor could be given with the appropriation available by making a cut across all of the shoals 12 feet deep, with a least width of 60 feet, and plainly marked.

Proposals were opened, after due advertisement, and a contract was made with the Alabama Dredging and Jetty Company to dredge and

mark the cuts for 25 cents per cubic yard. This was approved by the Chief of Engineers June 11, 1891. Work will be begun as soon as the contractor has completed the work in Hillsboro Bay, Florida. An examination and report on the harbor were also made as directed in the act. The report is printed with the Annual Report of the Chief of Engineers for 1891.

On May 24, 1892, the project was modified so that the amount available can be expended in deepening the channel from the wharf at Punta Gorda to Beacon No. 2, a distance of about 10,000 feet, to a depth of 12 feet.

The present depth of water in this portion of the channel varies from 10 feet at the wharf to 12 feet at Beacon No. 2.

The amount available is sufficient to excavate a channel 300 feet wide for a distance of 300 feet in front of the wharf, and 100 feet wide from that point to Beacon No. 2 to a depth of 12 feet.

It is believed that the depth obtained by dredging in this portion of the channel will be more likely to remain permanent than on the shoals in the vicinity of Cape Haze, as the material composing the bottom of the former consists principally of mud, while the latter are composed of sand of a more or less shifting character.

The estimated cost of forming a channel 200 feet wide and 12 feet deep at mean low water, from the Boca Grande entrance to the wharf at Punta Gorda is $127,555; for a channel 200 feet wide and 15 feet deep, it is $468,000.

The estimated cost of a channel 300 feet wide and 23 feet deep from the Gulf of Mexico to the deep anchorage just within Boca Grande entrance is 35,000.

Phosphate deposits are found in enormous quantities throughout the Pease River Valley, and the shipment of phosphates forms the principal commercial interests of the harbor; 55,095 tons were shipped during the year 1891, though the business is not yet fully developed. This phosphate was brought by rail to the wharf at Punta Gorda, and lightered from there to vessels lying in the Boca Grande anchorage. This point will be the point of shipment for phosphate from the Caloosahatchee River also, in all probability. Its importance is evident. Other shipments to and from Charlotte Harbor include grain, fish, and oysters, lumber, and general merchandise. An extension of the railroad to the Boca Grande entrance is projected.

Charlotte Harbor is in the collection district of Key West, and Tampa is the nearest port of entry; nearest light-house is Gasparilla Light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1891, balance unexpended	$32,113.56
June 30, 1892, amount expended during fiscal year	337.51
July 1, 1892, balance unexpended	31,776.05
July 1, 1892, amount covered by uncompleted contracts	29,500.00
July 1, 1892, balance available	2,276.05
Amount (estimated) required for completion of existing project	92,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Port of Punta Gorda, Fla., for years ending December 31, 1890–'92.

Entered.

Years.	Steamers.		Sailing vessels.		Total.
	No.	*Tons.*	*No.*	*Tons.*	*Tons.*
1890	71	53,665	67	7,598	61,063
1891	86	63,293	118	14,814	78,107

Cleared.

Years.	Steamers.		Sailing vessels.		Total.
	No.	*Tons.*	*No.*	*Tons.*	*Tons.*
1890	68	55,440	63	6,844	62,284
1891	86	74,203	118	20,649	94,852

Exports for years 1890 and 1891.

Articles.	1890.	1891.
Phosphate rock ... tons	13,480	55,095
Iced fish ... barrels	7,150	8,250
Salt fish ... pounds	299,000	425,000
Cattle ... head	2,389	658
Oranges ... boxes	10,094	6,200

Imports for year 1890.

Articles.	Morgan's steamship line.	Hinckley's Florida schooner line.	Total.
Corn ... sacks	12,821	7,172	19,993
Oats ... do	8,325	3,232	11,557
Bran ... do	1,544	1,447	3,221
Salt ... do	1,615	645	2,060
Hay ... bales	2,005	2,035	4,040
Flour ... barrels	7,815	1,448	9,263
Grits and meal ... do	2,346	547	2,893
Sundry packages	24,815	5,497	30,312

Imports for year 1891.

Articles.	Morgan's steamship line.	Hinckley's Florida schooner line.	Total.
Corn ... sacks	11,950	3,917	15,867
Oats ... do	7,225	1,900	9,125
Bran ... do	1,000	926	1,926
Salt ... do	600	....	600
Hay ... bales	1,450	1,101	2,551
Flour ... barrels	7,861	1,020	8,881
Grits and meal ... do	1,948	483	2,831
Sundry packages	32,312	2,762	35,074

O 8.

IMPROVEMENT OF SARASOTA BAY, FLORIDA.

Sarasota Bay extends south from Tampa Bay along the west coast of Florida. Its length between Tampa Bay and Casey Pass is 34 miles. It is separated from the Gulf of Mexico by a chain of low sandy keys, which vary in width from 300 feet to 1 mile.

There are five navigable entrances to the bay, one from Tampa Bay and four from the Gulf of Mexico. These are named in their order from north to south, Palma Sola or Sarasota Pass, Longboat Inlet, Big Sarasota Pass, Little Sarasota Pass, and Casey Pass, and have available channel depths of 4.3 feet, 5 feet, 7 feet, 5.3 feet, and 3.5 feet, respectively. Between Big and Little Sarasota passes the bay is divided in two parts, named Big Sarasota Bay and Little Sarasota Bay, respectively, by a cluster of small islands covered with mangrove bushes and known as the "Mangroves." The channels between these islands are narrow and crooked; at places are bare at low water.

Sarasota Bay is bordered by lands well suited for raising fruits and vegetables. The country roads are few and poor. The nearest railroads are at Port Tampa and St. Petersburg, on the north side of Tampa Bay, where are also steamship lines to Gulf ports and Cuba.

The products of this country include palmetto, agave, and banana fibers, honey, sugar, sirup, oranges, lemons, limes, bananas, pineapples, vegetables, lumber, fish, oysters, and cattle. Owing to the absence of regular and economical facilities for transportation, but few of these products are exported. Trade is limited to the actual necessities of the population.

A navigable channel with a minimum depth of 5 feet extends throughout the length of Big Sarasota Bay excepting in two reaches, Palma Sola Pass and Long Bar, which have a total length of 5,400 feet. In these reaches the available depth was 4.3 and 3.5 feet, respectively; the tidal range in the bay is 1.5 feet.

An examination and survey of the bay was made in 1889. The report thereon, with the project for improvement, is printed on page 1617, Vol. II, of the Report of the Chief of Engineers for 1890. An appropriation of $5,000 was made in the act approved September 19, 1890, for "improving Sarasota Bay from Tampa Bay to Sarasota, Fla."

The approved project calls for the formation of a continuous channel 100 feet wide and 5 feet deep at mean low water from Tampa Bay to the town of Sarasota, Fla., a distance of 21¼ miles.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

The United States steam snag and dredge boat *Suwanee* begun operations on October 31, 1891, and work was continued until February 13, 1892, when the exhaustion of funds available necessitated its discontinuance. The work was much retarded by stormy weather and the choking of the pump dredge by large clams, some as much as seven inches in diameter.

Following is a statement of the work accomplished:

Month.	Sand removed.	Length of cut.	Width of cut.	Depth of cut.
1891.	*Cubic yards*	*Feet.*	*Feet.*	*Feet.*
October	109.8	65	38	6
November	1,165.5	572	38	6
December	1,452.1	529	38	6
1892.				
January	1,075.3	357	38	6
February	560.8	150	38	6
Total	4,363.5	1,673		

The work has resulted in forming a cut through the shoal near Palma Sola Point 1,673 feet long and 36 feet wide. Dredging was done to a depth of 6 feet to allow 1 foot for back filling. A total of 4,363.5 cubic yards of sand (measured in place) were removed.

The cut requires to be extended 627 feet to connect the 5-foot contours on the shoal.

Sarasota Bay is in the collection district of Tampa, which is the nearest port of entry. Nearest light-house is Egmont Key Light. Nearest fort is Fort Taylor.

Money statement.

July 1, 1891, balance unexpended	$4,727.00
June 30, 1892, amount expended during fiscal year	4,666.73
July 1, 1892, balance unexpended	60.27
Amount appropriated by act approved July 13, 1892	2,500.00
Amount available for fiscal year ending June 30, 1893	2,560.27
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS, SARASOTA BAY, FLORIDA, DURING YEAR ENDING DECEMBER 31, 1891.

[Furnished by Mr. J. Hamilton Gillespie, Sarasota, Fla.]

Name of article	Quantity.	Estimated value.
Fertilizers ... tons	250	$7,500
Fish and oysters ... barrels	30,000	120,000
Fruits ... boxes	15,000	30,000
Bananas ... bunches	1,000	1,000
Grain ... bushels	10,000	8,000
Hides ... packages	50	500
Honey, sirup, etc ... gallons	3,000	1,500
Lumber, rough ... feet	150,000	1,800
sawed ... feet, B. M.	100,000	1,500
Merchandise ... tons	200	....
Vegetables ... boxes	5,000	10,000

NOTE.—The fish and oysters, lumber and fruits are estimated merely, as these are carried to and from so many points in the bay to or from Port Tampa or Manatee River. I am sure that I have not exaggerated the figures.

COMMERCIAL STATISTICS, SARASOTA BAY, FLORIDA, ETC.—continued.

Name of vessel.	Character.	Tonnage.	Draft of water.
		Tons.	*Feet.*
Jeannette	Schooner	14	4
Nellie Bly	do	9	2
Vision	do	9	4
Gracie	do	9	4
Ruby	do	5	3
Sea Turtle	Sloop	8	2

Estimated percentage of total trade of neighborhood carried by water, 90.
Probable increase of trade were the improvement completed, 300 per cent.

J. HAMILTON GILLESPIE.

SARASOTA, FLA., *May 18, 1892.*

The above statistics were accompanied by the following letter:

SARASOTA, FLA., *May 19, 1892.*

DEAR SIR: I duly received yours of 12th instant. It gives me much pleasure to assist in every way we can your efforts to report correctly on this section.

I have, after consultation with others, filled up one of your forms, and inclose it herewith.

Please note that we have to estimate almost everything, as there are so many points of ingress and egress on the bay. For instance, steamers call at several fishing points and take off the catch to Tampa, no record being available to us of quantities. Then there are many fishing and oyster vessels in the bay.

Your return makes no provision for some of our large shipments. To Key West, for instance, three schooners run from here regularly, carrying cattle, hogs, chickens, and potatoes. You may estimate these at the following figures: Cattle, 200 head; hogs, 2,000 head; chickens, 200 dozen; potatoes, sweet, 3,000 bushels.

Besides the vessels named in list there are a number of smaller boats, almost every settler having at least one, drawing from 6 inches to 2 feet.

Passengers are so uncertain, no proper accommodations being made for them and no record being kept of them, that I do not return them. They are few in number.

Trusting that our explanation may be of use, I remain,

Yours, very respectfully,

J. HAMILTON GILLESPIE.

Maj. J. C. MALLERY,
Corps of Engineers, U. S. A.

O 9.

IMPROVEMENT OF MANATEE RIVER, FLORIDA.

Manatee River rises in the southern part of Florida and flows in a westerly direction, emptying into Tampa Bay on its southern shore. For a distance of 12 miles from its mouth it has the characteristics of an estuary. For 10 miles the settlements along its banks are almost continuous. They comprise the towns of Manatee, Hendrix, Ellenton, Palmetto, Braidentown, and Palma Sola. Oranges and vegetables are raised in large quantities. From the fine ranges along the upper river hides, wool, and sheepskins are exported. Phosphate deposits have been discovered along the river, and mining operations are being carried on.

Before improvement, in the estuary the general depth of the river varied from 7 to 20 feet. At the mouth there was a long shoal with a depth of 7 feet. Between Palmetto and Manatee there was another bar covered by from 3 to 5 feet of water.

An examination of Manatee River, with a view to its improvement,

was made in 1881. A report thereon, dated February 16, 1882, with plan of improvement, is printed as part of Appendix K 25, Annual Report of the Chief of Engineers for 1882.

PROJECT OF IMPROVEMENT.

The original project had for its object to form a channel 100 feet wide and 13 feet deep at mean low water from Tampa Bay to Shaw and McNeil points, a distance of about 4 miles. The available depth before improvement was 7 feet.

Since the original project was adopted railroad and steamship lines have been established, which make Tampa the distributing point for the neighboring portion of Florida. Accordingly, it was decided to modify the project for the improvement of Manatee River, so as to open up the entire lower river to light-draft boats which would connect with the transportation lines centering at Tampa. The project as modified calls for the formation of a channel 100 feet wide and 8 feet deep at mean low water from Tampa Bay to Manatee. The inhabitants of the country bordering the Manatee desire the completion of the original project.

OPERATIONS PRIOR TO JUNE 30, 1891.

Work has been carried on under three appropriations, viz:

Act passed August 2, 1882	$12,000
Act approved August 5, 1886, allotment of	11,000
Act passed August 11, 1888	5,000
Act approved September 19, 1890	6,000
Total	34,000

With the appropriations of 1882, 1886, and 1888 a dredged cut was made across the bar at the mouth of the river, and a channel 105 feet wide and 8 feet deep at low water was dredged through the shoal between Manatee and Braidentown. Part of the appropriation of 1886 was expended in making a survey of the river. A report thereon, together with a map of the river, will be found on page 1109, Report of the Chief of Engineers for 1888.

The appropriation of $6,000 made in the act approved September 19, 1890, is still available. A channel 8 feet deep already exists from Tampa Bay to Manatee. Any further deepening of this channel should be begun at the bar at the mouth. The amount available would be barely sufficient to make a very narrow cut 12 feet deep across the bar. It is doubtful if an unprotected dredged cut of any width could be maintained there, and it is quite certain that money expended on a narrow cut would give no useful results.

On June 18 and 19 an examination was made of the outer bar and of the bulkhead lying in the mouth of the river between Snead and Shaws points. It was found that an available channel depth of at least 9 feet already exists on the outer bar, and that a cut through the bulkhead above referred to can be so located that advantage can be taken of the direction of the currents, so that its permanence would be reasonably assured. The steamboatmen are very anxious to have the cut made, as it would materially shorten and straighten the channel and avoid the necessity of crossing a long stretch of water having a depth of only 8 feet.

It is proposed to expend the money available in dredging a channel

through this bulkhead to such a width as the available funds will permit, limiting the depth, for the present, to that available on the outer bar.

Manatee River is in the collection district of Tampa. Tampa is the nearest port of entry. Nearest light-house is Egmont Key Light; nearest fort is Fort Taylor, Fla.

Money statement.

July 1, 1891, balance unexpended	$6,118.07
June 30, 1892, amount expended during fiscal year	96.20
July 1, 1892, balance unexpended	6,021.87
July 1, 1892, outstanding liabilities	46.35
July 1, 1892, balance available	5,975.52
Amount appropriated by act approved July 13, 1892	6,000.00
Amount available for fiscal year ending June 30, 1893	11,975.52
Amount (estimated) required for completion of existing project	33,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

O 10.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

Tampa Bay is a large indentation in the Gulf coast of Florida, with an average width of from 6 to 7 miles, and a length, including Hillsboro and Old Tampa bays, into which its inner end is divided, of 35 miles. Across the bar and up to the point of division, a distance of 25 miles, the channel has a depth of from 20 to 38 feet.

Old Tampa Bay, the northwestern division, is about 10 miles long, with an average width of 5½ miles. Near its mouth there is a channel depth of over 20 feet of water. A depth of 10 to 12 feet extends to its head. Hillsboro Bay has an average width of 5 miles, with depth varying from 16 feet at the mouth to 8 feet near the head. Flats with low-water depths of from 1 to 5 feet, varying in width from one-quarter to 1 mile, surround the entire body of water.

Its principal tributary is the Manatee River. The principal town is Tampa, lying at the mouth of the Hillsboro River, at the head of the Hillsboro Bay, but separated from the deep water of the bay by a broad flat, through which runs a narrow channel formed by the waters of the Hillsboro River. Through this, before improvement, vessels drawing 8 feet of water were able to reach Tampa only by taking advantage of high tides. The Florida Central and Peninsular Railroad has its terminus at Tampa.

The South Florida Railway now has its terminus at Port Tampa, near the mouth of Old Tampa Bay, where it makes connection with steamship lines for Key West, Havana, Mobile, and Central American ports. Port Tampa is about 9½ miles from Tampa, with which city it is connected by the railway, and for which it is the deep-water port.

An examination of Tampa Bay, with a view to its improvement, was made in 1879. A report thereon, dated August 25, 1879, with a plan of improvement, is printed as Appendix J 18 to the report of the Chief of Engineers for 1879.

FORMER PROJECT OF IMPROVEMENT.

The improvement proposed was to deepen and widen the channel from Tampa to the bay, a distance of 5¾ miles, by dredging and rock excavation, so as to give a clear depth of 9 feet at mean low water and a width in the river of 200 feet and in the bay of 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1888.

Work was done by contract under the following appropriations:

By act approved—	
June 14, 1880	$10,000
March 3, 1881	10,000
By act passed August 2, 1882	20,000
By act approved—	
July 5, 1884	20,000
August 5, 1886	10,000
August 11, 1888	25,000
September 19, 1890	25,000
Total	120,000

The work consisted entirely of dredging and rock excavation, and extended over a length of 8,200 feet, making a cut varying in width from 200 feet in the river to 60 feet in the bay. In the bay it has been partly filled by cross tidal currents. On June 30, 1887, it had a depth along the center line of from 8.3 to 9 feet. The depth in the bay beyond the outer extremity of the cut is 7 feet. The estimated cost of completing the dredged channel called for by this project is $63,000.

MODIFIED PROJECT.

In 1888 the project was changed. It now contemplates the formation of a channel 8 feet deep in Hillsboro Bay and Hillsboro River to the city of Tampa, and the formation of a channel 200 feet wide and 20 feet deep at mean low water from the outer bar to Port Tampa.

The estimated cost of the revised project was $60,000. Two appropriations have been made in the acts of 1888 and 1890, aggregating $50,000.

OPERATIONS PRIOR TO JUNE 30, 1891.

Operations were carried on under a contract with Mr. D. G. Ambler, dated March 22, 1889. The contract was completed March 28, 1891. During the entire contract 63,459 cubic yards of sand, shell, and silt were removed from the lower bulkhead (that at the entrance to Old Tampa Bay) and 12,058 cubic yards from the upper bulkhead (near Port Tampa). When work was suspended the cut at the entrance had a mean low-water depth of 20 feet and a width of 115 feet for one-half its length, and of 100 feet for the remaining distance, with an additional width of 75 feet the entire length, having a mean low-water depth of 16 feet. The upper cut was 150 feet wide, with a mid-channel depth of 19.7 feet. The tidal range is 1.5 feet.

A resurvey of the Hillsboro Bay Channel was made in January, 1891, by Mr. J. H. Bacon, assistant engineer. His estimate of the cost of completing an 8-foot channel 150 feet wide to Tampa is $33,000.

On May 11, 1891, proposals for continuing dredging operations and marking the cuts in Old Tampa and Hillsboro bays, under the appro-

priation of September 19, 1890, were opened after due advertisement. A contract for the work at 25 cents per cubic yard was made with the Alabama Dredging and Jetty Company, which was approved by the Chief of Engineers, June 11, 1891.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

Dredging under the contract with the Alabama Dredging and Jetty Company was begun in Old Tampa Bay December 19, and continued until May 12, when the channel called for by the project was completed. Twenty-three thousand six hundred and seventy cubic yards were removed from the lower bulkhead and 7,921 cubic yards from the upper bulkhead, a total under that contract of 31,591 cubic yards. Since commencement of work 95,050 cubic yards have been removed from the lower bulkhead and 19,979 cubic yards from the upper bulkhead, a total of 115,029 cubic yards.

Dredging under the same contract was begun in Hillsboro Bay on April 7, and still continues. Up to June 30, 21,073.2 cubic yards had been dredged, making the channel throughout the entire distance between the 8-foot contours 8 to 9 feet deep, and of a least width of 70 feet. In the bend near Spanish Town Point the width has been increased to 100 feet.

The dredging in Hillsboro Bay will probably be completed in August, 1892.

Tampa Bay is in the collection district of Tampa, which is the nearest port of entry. Nearest light-house is Egmont Key Light. Nearest fort is Fort Taylor, Fla.

Money statement.

July 1, 1891, balance unexpended		$24, 806. 00
June 30, 1892, amount expended during fiscal year		14, 801. 36
July 1, 1892, balance unexpended		10, 004. 64
July 1, 1892, outstanding liabilities	$5, 327. 59	
July 1, 1892, amount covered by uncompleted contracts	4, 080. 67	
		9, 408. 26
July 1, 1892, balance available		596. 38
Amount appropriated by act approved July 13, 1892		10, 000. 00
Amount available for fiscal year ending June 30, 1893		10, 596. 38

COMMERCIAL STATISTICS, TAMPA BAY, FLORIDA, DURING YEAR ENDING DECEMBER 31, 1891.

Name of article.	Gross tonnage.	Estimated value.
Fertilizers	2, 116	$63, 480
Phosphate	*34, 000	238, 000
Fish and oysters	2, 257	135, 420
Fruits	3, 006	225, 501
Fruits tropical	376	16, 920
Bananas	12, 203	152, 536
Grain	20, 221	707, 735
Lumber, rough	*20, 000	12, 000
Lumber, sawed	*8, 333	80, 000
Merchandise	27, 000	2, 160, 000
Vegetables	1, 302	180, 200
Railroad supplies	107, 000	2, 675, 000
Tobacco	296	1, 775, 400
Total	238, 110	8, 372, 192

* Estimated.

COMMERCIAL STATISTICS, TAMPA BAY, FLORIDA, ETC.—continued.

Vessels.	Character.	Number of trips.	Average tonnage.	Average draft.
				Feet.
Olivette	Steamship	76	1,611	13
Mascotte	...do	60	884	11
Juniata	...do	52	1,200	10
Aransas	...do	24	900	10
Hutchinson	...do	24	1,200	10
Lizzie Henderson	Steamer	24	250	7
Naugatuck	...do	15	300	7
Margaret	...do	75	250	7
Kissimmee	...do	250	188	5.5
Sadie	...do	160	85	5

In addition to the above there were 6 small steamers, averaging 120 tons each, and drawing from 3.5 to 4 feet of water; 34 foreign steamships, averaging 1,300 tons, and drawing from 16 to 20 feet of water; 38 foreign sailing vessels, averaging 750 tons, and drawing from 9 to 16 feet of water; 130 coasters, averaging 10 tons, and drawing from 2 to 4 feet of water, and 122 spongers, averaging 4 tons, and drawing from 2 to 5 feet of water.

Estimated number of passengers, 75,000.

Estimated percentage of total trade of neighborhood carried by water, 50.

Estimated increase of trade were the improvement completed, 25 per cent.

Respectfully submitted.

OTTO BIE,
U. S. Inspector.

O 11.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

The Withlacoochee River rises not far from Kissimmee, south of the center of the peninsula of Florida, and flowing north and west reaches the Gulf of Mexico at a point about 20 miles southeast of Cedar Keys. It has a total length of 120 miles. Pemberton Ferry, made the present head of navigation by the railroad trestle bridge of the South Florida Railroad, is 77 miles from the mouth. The roads of the Florida Railway and Navigation Company and of the Silver Springs, Ocala and Gulf Railroad Company touch the river at Panasoffkee and Dunnellon, respectively 57 and 31 miles from the mouth. The country bordering the river consists mainly of fine hummock land and cypress swamps. Large quantities of fruits and vegetables are grown and the country is fast being settled. Extensive deposits of phosphates have been discovered along the lower river.

The absence of good wagon roads and of parallel railroads greatly increases the importance of the Withlacoochee River as a means of communication and transportation.

Before improvement, this river was so badly obstructed that no regular navigation was possible, and the river was used only for rafting cedar logs or for an occasional push boat. The obstructions consisted of ledges of limestone rock, sand bars, snags, and overhanging trees. At certain points the river expands in broad, marshy lakes and cypress swamps, in which there is no clearly defined channel. The general depth was from 1 to 7.5 feet, with a width of from 75 to 180 feet.

Operations for the improvement of this river have been carried on in accordance with the project submitted to the Chief of Engineers in 1879 by the officer then in charge, and published as part of Appendix K 18 to the Annual Report of the Chief of Engineers for 1880.

PROJECT OF IMPROVEMENT.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and the deepening of some of the worst shoals and a bar at the mouth of the river, so as to enable boats drawing 2 feet to navigate the river during about one-half the year from the mouth to Hays Ferry, a distance of 71 miles. In 1886 the project was modified to permit the improvement to be continued as far as Pemberton Ferry, 6 miles from Hays Ferry.

OPERATIONS PRIOR TO JUNE 30, 1891.

Work was carried on under the following appropriations:

By act approved—	
March 3, 1881	$7,500
July 5, 1884	3,000
August 5, 1886	3,000
By act passed August 11, 1888	5,000
By act approved September 19, 1890	5,400
Total	23,900

The work was done partly by hired labor and partly by contract. The entire river from the mouth to Pemberton Ferry was gone over and the worst obstructions were removed.

At the close of operations the channel called for by the project had been formed between Pemberton Ferry and Dunnellon, though there are still obstructions which must be removed before navigation is safe. Between Dunnellon and the mouth are two dangerous rock ledges and many overhanging trees which require removal.

The services of the snag boat *Suwanee* not having been available on account of her work on the Caloosahatchee and Suwanee rivers, there were no operations during the fiscal year ending June 30, 1891.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

The snag boat *Suwanee* arrived at the mouth of the river on March 23. On account of the extraordinary low stage of the river the boat could not go farther up than about 18 miles below Dunnellon. An examination of the entire river was made, the low stage of water giving a very favorable opportunity. It was decided to lay up the snag boat, fit out a party from the crew, and proceed with the work of blasting the shoals, removing rock, and building training walls with the débris. The work of improvement has extended throughout the entire river from Pemberton Ferry to the mouth, and the channel called for by the project is nearly completed.

During the progress of the work 79 snags and 10 overhanging trees were removed, 465 cubic yards of rock were blasted, and 296 cubic yards of rock removed from the channel, and 128 linear feet of dams were built.

The growing commercial importance of the Withlacoochee River warrants a more extended plan of improvement, and I would renew the recommendations made in the Annual Reports for 1887 and 1888, that the project be modified so as to provide for navigation during the entire year over those portions of the river between Pemberton Ferry and Colton Grove, and between Morrison Landing and the mouth. The excepted reach is a broad, marshy lake, through which a low-water

channel could be formed and maintained only by dredging, to the detriment of the river above.

The estimated cost of this extension of the project is $22,400. Once formed the channel can be maintained at an annual expenditure not exceeding $800. In these rivers a channel is only kept open by constant use. An unused channel is soon rendered permanently unfit for navigation without expensive work by the dams and bars formed by the rapid accumulation of driftwood and water weeds, so that a complete opening of the river for navigation throughout the year is in the interest of economy, apart from the commercial advantages gained.

Withlacoochee River is in the collection district of St. Marks, Fla., of which Cedar Keys is the nearest port of entry. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1891, balance unexpended	$6,040.17
August 10, 1891, amount refunded by land-grant railroad	3.57
	6,043.74
June 30, 1892, amount expended during fiscal year	3,193.00
July 1, 1892, balance unexpended	2,850.74
July 1, 1892, outstanding liabilities	762.74
July 1, 1892, balance available	2,088.00

COMMERCIAL STATISTICS.

Commerce of Withlacooche River, Florida, during the year ending December 31, 1891.

Articles.	Quantity.	Gross tonnage.	Estimated value.
Fertilizers ... tons	500	500	$20,000
Fruits ... boxes	30,000	1,500	60,000
Grain ... bushels	20,000	600	15,000
Hides ... number	200	2	100
Honey, sirup, etc ... gallons	2,000	12	1,000
Logs ... feet	2,502,000	25,000	15,000
Merchandise ... tons	2,000	2,000	10,000
Vegetables ... boxes	3,000	150	6,000
Phosphate ... tons	75,000	75,000	450,000
Breadstuffs ... barrels	2,000	200	10,000
Total		104,964	587,100

Vessel.	Character.	Tonnage.	Draft of water.
		Tons.	*Feet.*
Louise	Screw propeller	10	3½

Passengers, 1,000; amount received from same, $250.
Estimated percentage of total trade of neighborhood carried by water, 10.
Probable increase of trade were the improvement completed, 100 per cent.

O 12.

IMPROVEMENT OF HARBOR AT CEDAR KEYS, FLORIDA.

The harbor at Cedar Keys is the most northern harbor on the Gulf side of the peninsula of Florida. It is formed by the tidal channels between a group of small islands or keys, of which Way Key, on which is situated the town of Cedar Keys, is the largest. Cedar Keys is the terminus of the central division of the Florida Central and Peninsula Railway. Its principal business is in cedar lumber, though it also forms a distributing point for supplies and general merchandise for an area to the north and south.

An examination of the harbor with a view to its improvement was made in November, 1883. A report thereon, together with a plan of improvement, was printed as Appendix N 30 to the report of the Chief of Engineers for 1884.

PROJECT OF IMPROVEMENT.

The approved project, as there described, is as follows: To obtain a channel 200 feet wide and with a least depth of 10½ feet from Cedar Keys to the Gulf of Mexico. A depth of 9½ feet formerly existed in this channel. The depth is limited by the existence of beds of rock under the entire channel from 9½ to 12½ feet below mean low water, water, which could only be removed at greater expense than the present and prospective commerce of the port would seem to warrant. The estimated cost of completing this project is $46,500.

Operations have been carried on under the following appropriations, viz:

Act of—	
July 5, 1884	$5,000
August 5, 1886	7,000
August 11, 1888	7,500
September 19, 1890	2,500
Total	22,000

The appropriation in the act approved September 19, 1890, was made in the following terms:

Improving harbor at Cedar Keys, Fla.: Continuing improvement, $2,500, a part of which may be expended at Derrick Island Gap on the inside channel from Suwanee River.

OPERATIONS PRIOR TO JUNE 30, 1891.

Between 1872 and 1881 cuts 200 feet wide and 11½ feet deep were made through the middle ground and through the outer bar. Under the appropriation of 1884 a cut 12 feet deep, partly through rock, was started near Buoy No. 12. It was never completed, owing to the exhaustion of the appropriation. The appropriation of 1886 was expended in reopening the cut through the middle ground, giving it a direction as nearly as possible coincident with the direction of the tidal currents. It was made 70 feet wide and 10½ feet deep. The appropriation of 1888 was expended in widening the same cut to 200 feet entirely through the middle ground, with a least depth of 9½ feet, excepting for a width of 60 feet along the east side, where it is 10 feet deep.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

The work of dredging through the oyster bars in the vicinity of Derrick Gap, or the inside passage between the mouth of the Suwanee River and Cedar Keys, under the appropriation of September 19, 1890, was begun by the United States steam snag and dredge boat *Suwanee* on August 11, 1891, and ceased, owing to the exhaustion of funds, on September 18, 1891; 3,962 cubic yards were dredged.

The aggregate length of the cuts at this place is 1,196 feet. The width is 37½ feet and the depth 6 feet at mean low water. Three hundred and ninety-eight cubic yards of sand and oyster shells were dredged at the crib stake at the East Pass, mouth of the Suwanee River, removing a small shoal at that place. A cut was made 380 feet long, and 75 feet wide for 167 feet of its length and 37½ feet wide for the remainder of the distance. The depth was 4½ feet at mean low water. Seventeen channel stakes, consisting of palmetto piles, were placed in the passage. A three pile beacon was erected at the south end of the cut between Cedar Keys and Depot Key. A similar beacon was established at the northeast end of the cut in Cedar Keys Harbor.

The commercial importance of Cedar Keys has steadily declined for some years. About the only water traffic that it has now is carried in very light-draft vessels, for which the harbor in its present condition affords ample facilities. I am unable to discover that there is any immediate prospect of an increase in the commerce of this port, and am of the opinion that the improvement there should be discontinued until an increased commerce, actual or fairly prospective, makes the further improvement necessary.

Cedar Keys is in the collection district of St. Marks, of which Cedar Keys is the headquarters. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion.

Money statement.

July 1, 1891, balance unexpended	$2,147.08
June 30, 1892, amount expended during fiscal year	1,941.17
July 1, 1892, balance unexpended	205.91
Amount (estimated) required for completion of existing project	44,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

O 13.

IMPROVING SUWANEE RIVER, FLORIDA.

The Suwanee River rises in the southern part of Georgia, near the Okefinokee Swamp, and, flowing in a general southerly direction, empties into the Gulf of Mexico a few miles north of Cedar Keys. The portion examined with a view to its improvement extends from Ellaville to the mouth. The country adjacent is well wooded, and the chief trade is in pine, cypress, and cedar timber, cotton, sirup, the minor farm products, and naval stores. Beds of phosphate rock have been discovered along the upper river.

Previous to the improvement the obstructions in the portion of the river under improvement consisted principally of shoals, composed of

soft unstratified limestone mixed with flint, extending either partly or entirely across the river, in some instances covered with shallow deposits of sand and in others bare. The channels across these shoals were often narrow and very crooked and their depths at extreme low water varied from 15 inches to 3 feet. At other places large isolated limestone bowlders in the channel were constant sources of danger to navigation.

An examination of this river with a view to its improvement was made in 1879. A report thereon dated August 26, 1879, with a plan of improvement, is printed as Appendix J 16, Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the bar at the passes by dredging, the removal of snags and overhanging trees along the river, and deepening and improving the channel at various places by the removal of rocks and snags, and construction of dams, so as to straighten, widen, and deepen the channel. The depth to be obtained is 5 feet through the bars at the passes for a width of 150 feet and up the river as far as New Branford, a distance of 80 miles. From there to Ellaville, a distance of 50 miles, the depth is to be 4 feet and the width 60 feet.

OPERATIONS PRIOR TO JUNE 30, 1891.

Work was done under the following appropriations:

By act approved—	
June 14, 1880	$5,000
March 3, 1881	3,000
By act passed August 2, 1882	5,000
By act approved—	
July 5, 1884	5,000
August 5, 1886	5,000
By act passed August 11, 1888	15,000
By act approved September 19, 1890	3,000
Total	41,000

Ten thousand dollars of the appropriation of August 11, 1888, were expended in the construction of a steam snag boat with dredging and pile-driving machinery, for use on the rivers of the west coast of Florida. The total amount appropriated for work on the river is $31,000.

Operations under the appropriations of 1880, 1881, 1882, and 1884 consisted entirely in dredging across the Suwanee Basin at the East Pass. On this line the distance from deep water of the gulf to deep water in the river is 15,600 feet. A cut 5,835 feet long, 60 feet wide, and 5 feet deep at mean low water was made, leaving a length of 9,765 feet to be dredged through water having an average depth of 3½ feet. This channel has since partly filled up.

Since 1886 the work in the upper river has comprised removing snags and overhanging trees, blasting and removing rock and bowlders, and constructing wing dams with the broken rock. A small amount of dredging was done at the Derrick Island Pass, at the entrance.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1892.

Work under the appropriation of September 19, 1890, which began on the river between Branford and Ellaville on May 17, 1891, was con-

tinued until July 6. Under this appropriation the following work was accomplished, viz:

Cubic yards of rock blasted	261.1
Cubic yards of rock removed	561.4
Snags (8 inches to 2 feet in diameter) removed	10

As a result of the work on this portion of the river there exists a navigable channel with not less than 3 feet in depth at the lowest known stage (1.1 feet below ordinary low water) as far as Hudson, although in two places the channel having this depth is only 30 feet wide.

The narrow, crooked channels, rapid currents, and rocky bed of that portion of the river between Ellaville and Branford render navigation dangerous whenever the water is low.

From Branford to the mouth the channel is in good condition. The channel through the Suwanee Basin is crooked, narrow in places, and has a least mean low-water depth of 3 to 4 feet.

On July 6 preparations were begun for proceeding to the work in the vicinity of Derrick Gap. The snag boat *Suwanee* left Branford July 8 and arrived at Cedar Keys on the 11th, where stores were taken on board and the machinery arranged for hydraulic dredging. The boat returned to Derrick Gap July 14, and preparation for work was continued. A careful survey of the channel was made and the line of the proposed cut laid out. On July 22 dredging was begun. Considerable difficulty was experienced in adapting the suction cutters to the character of the material found, which consisted principally of oyster shells. The work was also interrupted by severe wind squalls, which caused the mooring piles to be pulled down and the boat to get out of position. Most of the appropriation having been expended on the upper river, only 607 cubic yards of material were removed. The boat continued work under the appropriation for "improving harbor at Cedar Keys, Fla.: Continuing improvement, $2,500, a part of which may be expended at Derrick Island Gap, on the inside channel from Suwanee River." With the two appropriations a channel 1,196 feet long and 6 feet in depth was made.

FUTURE OPERATIONS.

The Suwanee River commerce comprises the movement of freight, farm produce, and naval stores to and from the railroads at Ellaville, New Branford, and Cedar Keys, and the rafting of cedar and other timber to the mills of the same towns. The roads are few and bad, and bulky produce can only be moved to advantage by water, so that an improvement of the stream which will make it continuously navigable is essential to the prosperity of the river valley. Excepting the traffic to and from Cedar Keys there is no movement of freight out of the mouth of the river. This fact renders it unnecessary to extend the cuts previously made through the Suwanee Basin to the deep water of the gulf, and restricts the work under the project, which the present commercial status renders necessary, to the clearing of the river channel proper and the dredging of the oyster bars from the Derrick Island Pass at the mouth. After the improvement has been made the channel can be kept clear with an estimated annual expenditure of $800.

The Suwanee River is in the collection district of St. Marks. Cedar Keys is the nearest port of entry. Nearest fort is Fort Marion. Nearest light-house, Cedar Keys Light.

Money statement.

July 1, 1891, balance unexpended	$1,322.93
August 10, amount refunded by land-grant railroad	.55
	1,323.48
June 30, 1892, amount expended during fiscal year	1,085.15
July 1, 1892, balance unexpended	238.33
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,238.33
Amount (estimated) required for the completion of existing project	21,158.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commerce of Suwanee River, Florida, during the year ending December 31, 1891.

[Furnished by Mr. W. S. Ivey, secretary Suwanee River Transportation Company.]

Articles.	Quantity.	Estimated value.	Gross tonnage.
Cotton ... bales	1,600	$100,000	320
Fertilizers ... tons	115	2,800	115
Fish and oysters ... barrels	875	4,000	13
Fruits ... boxes	1,750	1,800	43
Grain ... bushels	65,000	55,000	1,550
Hides ... number	3,500	2,000	179
Honey, sirup, etc ... gallons	10,000	3,700	58
Lumber:			
Rough ... feet, B. M.	2,000,000	70,000	5,375
Sawed ... do	150,000		
Merchandise ... tons	6,000	700,000	6,000
Ship stores ... barrels	31,000	200,000	7,750
Vegetables ... boxes	600	700	18
Cedar logs ... feet, B. M.	1,750,000	60,000	5,250
Cedar in cases ... cubic feet	37,000	100,000	740
Moss ... bales	1,000	2,000	5
Total	....	1,302,000	27,416

Vessel.	Character.	Tonnage.	Draft of water.
			Feet.
Belle of Suwanee	Sternwheel steamer	183	2¼
Dolphin	......do	10	1½
Wekiva	Screw steamer	10	2

Number of passengers, 6,500.
Estimated percentage of total trade of neighborhood carried by water, 75.
Probable increase of trade were the improvement completed, 40 per cent.
The proper opening or removing the present obstructions in the channel of river will develop vast mining of phosphate rock adjacent the Suwanee.
In making this report I have confined myself to the business of this port exclusively. You must know that there is a great volume of the Suwanee River traffic that does not touch at this point, viz: Cedar Keys, Fannin, Old Town, Yular, Hatch Bend, New Troy, Mayo, and Luraville.

Yours, truly,

W. S. IVEY.

BRANFORD, FLA., *June 30, 1892.*

APPENDIX P.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, FLORIDA, AND ALABAMA.

REPORT OF CAPTAIN PHILIP M. PRICE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Apalachicola Bay, Florida.
2. Apalachicola River, Florida.
3. Flint River, Georgia.
4. Chattahoochee River, Georgia and Alabama.
5. La Grange Bayou and Holmes River, Florida.
6. Choctawhatchee River, Florida and Alabama.
7. Harbor at Pensacola, Florida.
8. Escambia and Conecuh rivers, Florida and Alabama.
9. Alabama River, Alabama.
10. Tallapoosa River, Alabama.
11. Coosa River, Georgia and Alabama.
12. Operating and care of canals and other works of navigation on Coosa River, Georgia and Alabama.
13. Cahaba River, Alabama.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., July 9, 1892.

GENERAL: I have the honor to forward herewith annual reports in duplicate for the fiscal year ending June 30, 1892, upon the works under my charge.

* * * * * * *

Very respectfully, your obedient servant,

PHILIP M. PRICE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

P 1.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

PLAN OF IMPROVEMENT.

The report by Maj. A. N. Damrell of the examination of Apalachicola Bay, Florida, is printed in the Report of the Chief of Engineers for 1879, page 823. The minimum depth of water over the bar at the mouth of the Apalachicola River was then 3½ feet.

In accordance with the recommendations therein a project was approved which contemplated the dredging of a straight channel through the bar at the mouth of the river to a depth of 11 feet and a width of 100 feet, to be afterwards increased to 200 feet should the first cut produce results to warrant it, at an estimated cost of $100,000.

A survey of the mouth of the Apalachicola River and of a portion of Apalachicola Bay was made in 1891 by Assistant Engineer Thomas Robinson, and the report thereon was submitted by me on May 15, 1891.

In accordance with the recommendations of this report the present project was approved, viz:

To dredge a channel through the bar at the mouth of the Apalachicola River to a depth of 11 feet, with a width of 100 feet, to be afterwards increased to 200 feet should the first cut produce results to warrant it; and a channel through Bulkhead Shoal 9 feet deep and not less than 100 feet wide.

The commerce of Apalachicola Bay consists principally in the exportation of lumber. Ships generally enter through East Pass, between St. George and Dog islands, and anchor under the shelter of these islands, about 24 miles from the town of Apalachicola. The lumber is carried on lighters, towed by tugs drawing from 5 to 7 feet, from Apalachicola to the anchorage grounds, and there loaded on ships for export. The tugs employed in the traffic have trouble only at the bar and at Bulkhead Shoal, when the depth of water at these places is less than 8 feet. It is believed that the 9-foot channel now dredged through Bulkhead Shoal will be reasonably permanent, but experience shows that the bar at the mouth of the Apalachicola River will require redredging at least every two years, unless the dredged channel is made wider and deeper than the appropriations have hitherto permitted.

APPROPRIATIONS.

March 2, 1833	$8,700	July 5, 1884	$10,000
July 4, 1836	10,000	August 5, 1886	12,000
March 3, 1839	9,900	August 11, 1888	20,000
June 14, 1880	10,000	September 19, 1890	20,000
March 3, 1881	10,000		
August 2, 1882	25,000	Total	135,600

OPERATIONS TO JUNE 30, 1891.

The bar at the mouth of the Apalachicola River is about 7,300 feet in width. A straight channel has been dredged across this bar from time to time since 1881 as funds have been available; but, on account of the limited appropriations, the dredged cut has never exceeded 90 feet in width and 9½ feet in depth, and has gradually filled up after each dredging.

WORK DONE DURING PAST FISCAL YEAR.

Under the contract of July 27, 1891, approved August 3, 1891, for dredging at Bulkhead Shoal, at 25 cents per cubic yard, the Alabama Dredging and Jetty Company, of Mobile, Ala., began work October 26, 1891. On February 6, 1892, a straight channel about 4,000 feet long, 120 feet wide, and 9 feet deep was completed over this shoal by the removal of 54,458 cubic yards of material. A small balance of the appropriation was still available.

The straight channel through the bar at the mouth of the Apalachi-

cola River had, in some places, shoaled to less than 6 feet, and much trouble was experienced by the tugs in passing through it. The Chief of Engineers authorized the expenditure of the balance available in dredging such shoal places, under an arrangement with the Alabama Dredging and Jetty Company, on the terms that they had been working under on Bulkhead Shoal. Under this arrangement 11,461 cubic yards were dredged from the straight channel between February 6 and 27, 1892, when the work was suspended on account of the exhaustion of funds.

Assistant Engineer Thomas Robinson has continued in local charge of the work during the past year.

RECOMMENDATION AND ESTIMATES.

The pending river and harbor bill appropriates $20,000 for Apalachicola Bay. Should the bill become a law it is anticipated that a channel at least 90 feet wide and 8 feet deep may be dredged through the bar at the mouth of the river during the fiscal year ending June 30, 1893. A channel of this width and depth will, however, soon partially fill up. It is probable that a wider and deeper channel may be more permanent, and an estimate of $50,000 is therefore submitted for the fiscal year ending June 30, 1894.

Money statement.

July 1, 1891, balance unexpended	$18,461.24
June 30, 1892, amount expended during fiscal year	18,412.31
July 1, 1892, balance unexpended	48.93
July 1, 1892, outstanding liabilities	13.50
July 1, 1892, balance available	35.43
Amount appropriated by act approved July 13, 1892	20,000.00
Amount available for fiscal year ending June 30, 1893	20,035.43
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	50,000.00

Abstract of bids received and opened on July 15, 1891, by Capt. Philip M. Price, Corps of Engineers, for dredging in Apalachicola Bay, Florida.

No.	Name and address of bidder.	Price per cubic yard.
		Cents.
1	John H. Gardner, Apalachicola, Fla	39.7
2	Alabama Dredging and Jetty Co., Mobile, Ala	25

COMMERCIAL STATISTICS FOR APALACHICOLA BAY, FLORIDA.

[Furnished by the special deputy collector of customs.]

Statement of the commerce of the port of Apalachicola, Fla., from July 1, 1891, to June 30, 1892, inclusive.

Custom-house receipts from all sources:	
Duties on imports	$5.25
Tonnage dues	1,018.56
Official fees	406.41
Total	1,430.22

Vessels entered, 93; tonnage, 39,237. Vessels cleared, 104; tonnage, 40,336. Vessels employed in traffic of Apalachicola Bay, 102. Superficial feet of timber and lumber exported, 31,398,731. Estimated number of vessels and river steamers arrived and departed, 692. Estimated tonnage of above vessels, 88,000.

Exports.

To foreign ports	$183,182
To coastwise ports	360,000
Total	543,182

Imports.

From foreign ports	$21
From coastwise ports	212,000
Total	212,021

Total value of imports and exports, $755,203.

Estimated value of exports to coastwise ports by sail vessels and river steamers which do not clear from the custom-house, $750,000. Estimated value of imports to coastwise ports by sail vessels and river steamers, which do not clear from the custom-house, $1,210,000.

There are five sawmills here, which can turn out 300,000 superficial feet of lumber per day, with shingle attachments which can turn out 200,000 shingles per day; three oyster-canning factories, with a capacity of 50,000 cans per day; one fish-packing establishment, which packs about 5,000 barrels of salted and pickled fish per annum; one ice factory, manufacturing 7 tons of ice per day.

All the above enterprises expect to do double the amount of business during next fiscal year, principally on account of reciprocity treaties now in force with West India Islands and other countries.

P 2.

IMPROVEMENT OF APALACHICOLA RIVER, FLORIDA.

PLAN OF IMPROVEMENT.

The report of the examination and survey of the Apalachicola River is printed in the Report of the Chief of Engineers for 1873, page 698.

The Apalachicola River is formed by the junction of the Chattahoochee and Flint rivers and is about 105 miles long from the junction to Apalachicola Bay. The channel is nowhere less than 6 feet deep, but is more or less obstructed after each freshet in the Chattahoochee and Flint rivers by logs and snags brought down by those rivers.

At Moccasin Slough and at the Upper and Lower Elbows the channel is very narrow and crooked and difficult to navigate, and needs straightening and widening.

The act of August 11, 1888, directed an examination of the Chipola River, Lee Slough, and the cut-off. The report of this examination is printed in the annual report of the Chief of Engineers for 1889, page 1416.

The act of September 19, 1890, appropriated $2,000 for maintaining the existing works on the Apalachicola River, including Lee Slough.

The original project was modified accordingly, and now provides for securing a channel 100 feet wide and 6 feet deep at low water in the Apalachicola River by the removal of snags and overhanging trees and widening and straightening Moccasin Slough and the Elbows, and for securing a channel through the cut-off, Lee Slough, and the Lower Chipola River, 60 feet wide and 5 feet deep at low water, by the removal

of logs and snags and overhanging trees. The estimated cost of completing the original project was $80,333 and of the improvement of the cut-off, Lee Slough, and the Lower Chipola River $7,500.

APPROPRIATIONS.

May 23, 1828	$3,000	March 3, 1881	$1,500
April 23, 1830	2,000	August 2, 1882	2,000
March 2, 1831	8,000	July 5, 1884	1,000
June 23, 1874	10,000	August 5, 1886	1,000
March 3, 1875	10,000	August 11, 1888	2,000
June 18, 1878	8,000	September 19, 1890	2,000
March 3, 1879	5,000		
June 14, 1880	2,000	Total	57,500

OPERATIONS TO JUNE 30, 1891.

Between 1874 and 1880 the accumulation of logs and snags was removed from the channel and a partial improvement was made at Moccasin Slough and the Elbows. Since 1880 the appropriations have only sufficed to remove the snags and logs annually brought down by freshets in the rivers above. There is no plant belonging to this river, and the annual snagging work was done by the Chattahoochee River snag boat at times when the water in the latter river was too high for channel work.

The river was then in a fairly good navigable condition, except at Moccasin Slough and the Elbows.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, who is in local charge of the improvement, reports as follows:

In December, 1891, the snag boat *Chattahoochee* was loaned to this improvement and employed in the removal of drift and obstructing timber from the Apalachicola River, the cut-off, and Lee Slough. From these waterways a total of 520 overhanging trees, 344 projecting drift logs, and 14 stumps were removed from the banks, and 313 snags taken out of the channel.

Results.—As a result of this work the river steamers were enabled to run the main river with tolerable safety, while the clearance of the cut-off and upper end of Lee Slough greatly facilitated the shipment of the orange and other crops from the neighborhood of Wewahitchka.

RECOMMENDATIONS AND ESTIMATES.

It is estimated that $2,000 will be required for the annual snagging operations needed to clear out the logs and snags brought in by freshets in the Flint and Chattahoochee rivers, and that, by using the Chattahoochee and Flint River snag boats, a channel through Lee Slough can be cleared out in one season with an appropriation of $7,500, and that the needed improvements can be effected at Moccasin Slough and the Elbows with $5,000.

Money statement.

July 1, 1891, balance unexpended	$754.47
June 30, 1892, amount expended during fiscal year	754.47
Amount appropriated by act approved July 13, 1892	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	14,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

All of the steamboats which run on the Chattahoochee River also run on this river, their regular trips being made between Columbus, Ga., and Apalachicola, Fla., at the mouth of the Apalachicola River.

It is not possible to state the amount of business done on the Apalachicola River separately from that done on the Chattahoochee River, but, in general terms, it may be stated that it is the same.

Reference is therefore made to the report on the Chattahoochee River for commercial statistics.

P 3.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adopted in accordance with the recommendations contained in the reports of examinations and surveys of the Flint River, printed in the Annual Reports of the Chief of Engineers for 1873, page 707, and 1879, page 818.

The project provides for a low-water channel 3 feet deep and 100 feet wide from the mouth of the river to Albany, Ga., an estimated distance of 105 miles; and a navigable channel for light-draft steamers, at moderate stages of water, from Albany to Montezuma, Ga., an estimated distance of 77 miles; to be secured by the removal of snags and overhanging trees, cutting through the rock reefs, and deepening sand bars by works of contraction and shore protection.

Below Albany the work is principally upon the rock bottom of the river, and the improvement effected is of a permanent character. The snags and logs brought down by the winter freshets must, however, be removed annually. Between Albany and Warwick, 38 miles above, the low-water navigation is prevented by a series of rock shoals, on which the low-water depth is from 6 to 18 inches.

Between Warwick and Montezuma the improvement consists mainly in the removal of snags and logs and overhanging trees.

APPROPRIATIONS.

For the Chattahoochee and Flint rivers:		March 3, 1879	$7,000
June 23, 1874	$25,000	June 14, 1880	20,000
March 3, 1875	25,000	March 3, 1881	15,000
August 14, 1876	20,000	August 2, 1882	25,000
		July 5, 1884	20,000
	*70,000	August 5, 1886	20,000
June 18, 1878	10,000	August 11, 1888	20,000
		September 19, 1890	20,000

OPERATIONS TO JUNE 30, 1891.

A moderately efficient working plant had been provided for rock excavation below Albany, Ga., and for snagging operations above Albany.

A navigable channel about 3 feet deep at low water, and varying from 50 to 100 feet in width, had been excavated through the rock reefs

*Of this amount $18,000 was expended on the Flint River.

below Albany; but low-water navigation was difficult on account of insufficient width of the channel.

Above Albany the river had been partially cleared of logs and snags, and to a limited extent the channel had been cleared of loose rock.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, who has been in local charge of the improvement, reports as follows:

Between Albany and Montezuma the snag boat *Flint* worked for four months, and cleared a channel for navigation at moderate stages of water over a distance of 50 miles. In this period there were removed 1,652 overhanging trees from the banks, and 1,785 logs and snags from mid-channel. At the close of October, the appropriation being exhausted, work was stopped and the attempt made to drift the boat down the river to winter quarters below Albany. In process of this drift, at a low stage of the river, while passing the rapids at Abram Creek Shoals, the snubbing lines parted and the boat was thrown on to a rock pinnacle at the foot of the rapids and sunk. Bulkheads were built around the break in the hull, the water pumped out, and on a rise of the river the boat was floated down to winter quarters, docked and repaired, and there it still lies in charge of a watchman.

Below Albany.—Work on the shoals near Albany was continued until early in November, when the work being completed in accordance with the requirements of the project, the drilling barge was started down the river to finish the work of straightening and widening the channel at those points which had been purposely left undone. Before the high water put a stop to the work the boat reached Tea Cup Shoals, 20 miles below Albany, where it was laid up for the winter. In May, 1892, work was resumed by the drilling barge and continued to Lucky Island. During the whole working period the drilling barge removed 508 overhanging trees from the banks, and 444 snags and 3,203 cubic yards of rock from mid-channel. The rock dump was deposited wherever needed to form substantial wing dams, and a total length of 380 linear feet of these was laid.

Results.—Between Albany and Montezuma the work of the fiscal year closing June 30, 1892, left the river, previous to the last winter freshets, free from snags and other drift obstructions; but the stream is of little use to commerce so long as the railroad bridge 16 miles, and the Drayton bridge 41 miles above Albany remains without draw openings, and the rock shoals between Albany and Warwick are left uncleared.

Below Albany.—There is now a completed and permanent channel from Albany to Lucky Island, a distance of 22 miles. From Lucky Island to the mouth of the river, a distance of 93 miles, the channel, with care, is passable at ordinary low water; but at extreme low water it is, in many places, difficult and dangerous and prohibitory to commerce.

Recommendations.—There appears to be no demand of commerce for the Flint River between Albany and Montezuma; a thorough clearance of the stream would be a costly job, incommensurate with all returns, and it is therefore recommended that no further work be done upon that portion of the river.

There is a present demand, and a probably greater future need, for the waterway below Albany; and it is recommended that the present plan of widening and straightening the channel through the shoals, by the removal of ledges and bowlders and the deposition of the dump to form dikes and jetties, be continued until the improvement is completed in accordance with the requirements of the adopted project.

The working plant, consisting of snag boat, drilling barge, and dumping flat, with their equipment, is in fair condition. A change, however, in working appliances from hand tools and cranes to steam drills and grappling apparatus is desirable. Were the snag boat *Flint* no longer needed for the river above Albany, it could be readily transformed into a steam appliance barge; and the utilization of its present boiler and engine would greatly reduce the cost of any change that might be made.

RECOMMENDATIONS AND ESTIMATES.

The bridge of the Albany Navigation and Construction Company, 16 miles above Albany, and the bridge of the Flint River Bridge Company, at Drayton, 41 miles above Albany, are without draw openings. The height of the superstructure above ordinary high water is 18 feet and 14 feet respectively. High-water navigation is, therefore, completely obstructed by the bridges, but no proceedings to compel the insertion

of draw spans have been instituted, for the reason that no complaint has been made against them by anyone wishing to run a steamboat on this portion of the river. An appropriation of $40,000 for the fiscal year ending June 30, 1894, is recommended, in order that a suitable plant may be provided, and the rockwork between Albany and Bainbridge pushed to completion.

Money statement.

July 1, 1891, balance unexpended	$16,809.17
June 30, 1892, amount expended during fiscal year	12,080.74
July 1, 1892, balance unexpended	4,728.43
July 1, 1892, outstanding liabilities	794.81
July 1, 1892, balance available	3,933.62
Amount appropriated by act approved July 13, 1892	15,000.00
Amount available for fiscal year ending June 30, 1893	18,933.62
Amount that can be profitably expended in fiscal year ending June 30, 1894	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Assistant Engineer Thomas Robinson, in local charge of the improvement, reports as follows:

Above Albany.—None. I have made inquiries of all intelligent men I have met about the needs of this waterway for commerce, and I have found but one man who expressed any favorable idea toward any further improvement. That man wished the river cleared so that he might run a small boat "to carry liquor into the dry counties along the river."

Between Albany and Bainbridge.—Mr. Ed. L. Wight, president Albany Navigation Company, reports as follows:

Stern-wheel steamboat.	Registered tonnage.	Draft of water.		Round trips made between places.	No. of passengers.
		Light.	Loaded.		
	Tons.	Inches.	Inches.		
City of Albany	49	20	36	48	200

Freight carried.

	Tons.		Tons.
Cotton (600 bales)	120	Provisions (5,000 packages)	250
Cotton seed (1,000 sacks)	50	Grain (2,500 sacks)	13
Fertilizers (3,500 sacks)	350	Miscellaneous freight (1,000 packages)	5
Hides and skins (200 packages)	1		
Live stock (40 head)	1		
Lumber (25,000 feet)	50	Total	840

Estimated value of above freights (in round numbers) $133,000.

This section of the river has been navigable except during October, November, and December. Head of navigation has been Albany, Ga., for high and low water.

The improvement of the river has opened up a large territory of fine timber and farm lands, induced the establishment of sawmills and turpentine distilleries along the river, and made good markets easily accessible for farm products, lumber, and naval stores, and brought the merchants in direct communication with the centers of trade; all of which will be further advanced by opening up a better channel.

The making of this stream navigable is a great benefit to a large section of country not accessible to any railroad.

Between Bainbridge and the junction with the Chattahoochee River.—The steamboats which run on the Chattahoochee and Apalachicola rivers also run on this portion of

the Flint River, going to Bainbridge on almost every regular trip. It is, therefore, impossible to state the amount of business done on this portion of the Flint River separately from that done on the Chattahoochee and Apalachicola rivers; but in general terms it may be stated that the business on this portion of the river is practically the same as that on the Chattahoochee River, for commercial statistics of which reference is made to the report on that river.

P 4.

IMPROVEMENT OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adopted in accordance with the recommendations contained in the reports of examinations and surveys of the river, printed in the Annual Reports of the Chief of Engineers for 1872, page 584, and 1873, page 699.

The project provides for a low-water channel 4 feet deep and 100 feet wide, from Columbus, Ga., to Chattahoochee, Fla., an estimated distance of 224 miles, by the removal of snags and logs from the channel and overhanging trees from the banks, cutting a channel through the rock shoals, and deepening sand bars by works of contraction and shore protection.

The improvement at many points is of a permanent character, the bottom of the river being of rock, and the banks not easily eroded; at a few points the obstructions consist of shifting sand bars and caving banks. Each freshet brings a considerable number of logs and snags into the channel, which must be removed annually.

In addition to such amounts as may be appropriated for continuing the improvement of the river, an annual expenditure, estimated at $10,000, will be required for the maintenance of a stern-wheel snag boat, and for the repair of works of contraction and shore protection.

APPROPRIATIONS.

February 24, 1835	$2,000	March 3, 1879	$15,000
		June 14, 1880	20,000
Chattahoochee and Flint rivers—		March 3, 1881	20,000
June 23, 1874	25,000	August 2, 1882	25,000
March 3, 1875	25,000	July 5, 1884	35,000
August 14, 1876	20,000	August 5, 1886	20,000
		August 11, 1888	20,000
	*70,000	September 19, 1890	20,000
June 18, 1878	18,000	Total	193,000

OPERATIONS TO JUNE 30, 1891.

A stern-wheel snag boat had been built and maintained for snagging operations, with which the channel had been kept clear of obstructions of that character, except during limited periods, when funds were not available. A moderately efficient working plant had also been maintained for operations upon the rock shoals. Works of contraction had been constructed to a limited extent, but with the funds available it had not been practicable to keep them in repair, nor to extend nor modify them, as required.

*Of the joint appropriations, $52,000 was expended on the Chatahoochee River.

Navigation had been greatly benefited by the incomplete improvements, so that steamboats then made regular trips between Columbus, Ga., and Apalachicola, Fla., running by night as well as by day, with few detentions, except at extreme low water. Formerly they could only run by day, and were frequently detained at the shoal bars for days at a time, and many boats were sunk by striking logs and snags.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, who has been in local charge of the improvement, reports as follows:

In July, 1891, the drilling barge was converted into a pile-driver, and the snag boat *Chattahooche* was started to remove the scattered obstructions along the river. In this work 924 overhanging trees were felled and cut up; 33 trees were trimmed; 81 drift logs were cut up on the bank, and 366 snags removed from the channel.

When this work was finished the snag boat and pile-driving barge began the improvement of Mound Bar by the construction of pile and brush bank protection, training walls and jetties, and the removal of gravel and clay from the channel. At this place a total of 1,110 linear feet of jetties and bank protection were constructed, a work which involved the driving and bracing of 992 piles, the cutting and deposit of 480 cords of brush, and the transplanting of 1,082 willows and other suitable trees. A channel 600 feet long and 30 feet wide was cleared by plow and road-scrapers, pulled by the steam capstans, which removed 1,098 cubic yards of gravel and 403 cubic yards of clay. At the close of November the work, unfinished, was brought to a close by exhausted funds and the setting in of winter rains.

The work at Mound Bar has determined the location of the low-water flow of the stream, and so far, at that place, the boats have been enabled to run unimpeded.

RECOMMENDATIONS AND ESTIMATES.

At Mound and Woolfolk bars, below Columbus, the banks are caving, and low-water navigation is yearly becoming more difficult. The necessary improvement will become more expensive the longer it is delayed. The channel through the marl reef at St. Francis Bend should also be widened and straightened.

The hull of the stern-wheel snag boat *Chattahoochee* is now worn out and is not worth further repairs. The maintenance of this snag boat in good condition is absolutely essential to the safe navigation of the river, for each freshet brings logs and snags into the channel which must be removed. The cost of renewing the hull of the snag boat is estimated at $10,000.

An estimate of $100,000 is submitted for the fiscal year ending June 30, 1894. With this amount the snag boat can be renewed and operated during the low-water season, and the improvements needed at Mound Bar and Woolfolk Bar and St. Francis Bend can be effected. It is probable that thereafter an annual appropriation of $10,000 will suffice for the annual snagging operations and for the maintenance of the contraction and shore-protection works.

Money statement.

July 1, 1891, balance unexpended	$11,076.98
June 30, 1892, amount expended during fiscal year	9,604.64
July 1, 1892, balance unexpended	1,472.34
July 1, 1892, outstanding liabilities	373.29
July 1, 1892, balance available	1,099.05
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	26,099.05
Amount that can be profitably expended in fiscal year ending June 30, 1894	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

The following statement of the business done by the steamboats named below during the fiscal year ending June 30, 1892, has been compiled from statements furnished by Capt. W. R. Moore, agent People's Line of Steamers, by Capt. George B. Whiteside, agent for steamers *Pactolus*, *Naiad*, and *Queen City*, J. D. Smith, manager steamer *W. D. Ellis*, and I. Joseph, manager steamer *Fannie Fearn*. These boats run from Columbus, Ga., to the junction of the Chattahoochee and Flint rivers; thence up the Flint River to Bainbridge, Ga.; then returning to the junction, down the Apalachicola River to Apalachicola, Fla. On the return trip they go first to Bainbridge, then to Columbus. They stop at any intermediate landings where business is offered.

Stern-wheel steamboats.	Registered tonnage.	Draft of water.		Between—	Round trips.	Passengers.
		Light.	Loaded.			
		Inches.	*Feet.*			
Fannie Fearn	179.32	24	5	Columbus and Apalachicola	39	3,989
Apalachee	162.00	28	5	......do	38	6,745
William D. Ellis	146.15	24	3½	......do	12	....
Pactolus	149.12	24	5			
Naiad	173.77	18	4½	Columbus and Apalachicola	25	3,951
Queen City	150.03	22	5	Columbus, Apalachichla, and intermediate landings.	99	8,119

Freight carried.

	Tons.
Cotton (18,725 bales)	4,534
Cotton seed (11,231 sacks)	611
Fertilizers (38,745 sacks)	3,874
Hides and skins (167 packages)	16
Live stock (228 head)	84
Lumber (160,558 feet)	357
Staves (54,165 pieces)	108
Provisions (227,908 packages)	7,276
Grain (20,422 sacks)	1,454
Miscellaneous freight (230,527 packages)	9.221
Brick (730,373)	1,644
Shingles (11,752,080)	2,180
Total	31,359

Estimated value of above freight in round numbers $5,000,000.

The rafting of hewed and sawed timber and logs is also carried on extensively, but no available records of the business are kept.

P 5.

IMPROVEMENT OF LA GRANGE BAYOU AND HOLMES RIVER, FLORIDA.

PLAN OF IMPROVEMENT.

An examination of La Grange Bayou was ordered by act of March 3, 1881. The report of the examination, by Capt. Damrell, including an estimate for deepening the channel by dredging, to admit the passage of vessels drawing 4½ feet at mean low water, at a cost of $19,994.30, was printed in the Report of the Chief of Engineers for 1882, page 1318.

The act of August 2, 1882, provided for the expenditure on La Grange Bayou of $2,000 of the $20,000 appropriated for the improvement of the Choctawhatchee River.

The act of August 5, 1886, appropriated $2,000 for the improvement of La Grange Bayou, but as so small a sum could not be profitably ex-

pended, it was decided to hold it until a further appropriation was made.

The act of August 11, 1888, appropriated $3,000 to complete the improvement of La Grange Bayou, including Holmes River as far as the town of Vernon.

In February, 1889, an examination of both La Grange Bayou and Holmes River was made. This examination showed that the improvement could not be completed with the amount available, and the Secretary of War therefore directed that no further expenditure should be made from the appropriations.

There is a balance still available from the appropriations of August 5, 1886, and August 11, 1888, of $4,839.20.

The act of September 19, 1890, made an appropriation for "improving La Grange Bayou, Florida, continuing improvement of Holmes River, $3,000."

Under this appropriation, a project was approved for improving Holmes River by removing logs and snags from the channel and overhanging trees from the banks, between the mouth and the town of Vernon, Fla., an estimated distance of 28 miles.

APPROPRIATIONS.

June 15, 1844, for Choctawhatchee and Holmes rivers	$10,000
August 2, 1882, allotted from appropriation for Choctawhatchee River	2,000
August 5, 1886	2,000
August 11, 1888, to complete the improvement of La Grange Bayou, including Holmes River as far as the town of Vernon	3,000
September 19, 1890, improving La Grange Bayou, Florida; continuing improvement of Holmes River	3,000

OPERATIONS TO JUNE 30, 1891.

The allotment of $2,000, under the act of August 2, 1882, was expended in the removal of snags and logs, and in dredging about 3,500 cubic yards of mud from the channel in La Grange Bayou; since then no work has been done at the bayou.

Under the act of September 19, 1890, $3,000 was expended in removing snags and logs from the channel, and overhanging trees from the banks of the Holmes River, between its mouth and Vernon, Fla. For this purpose the snag boat belonging to the Choctawhatchee River was used. The work was completed in February, 1891.

RECOMMENDATIONS AND ESTIMATES.

There are no bars in the Holmes River, and it is probable that its navigation will not be again impeded by snags and overhanging trees for several years. There is but little commerce on it. It is therefore recommended that no further appropriations be made for its improvement until such time as the necessities of commerce may require it.

Money statement.

July 1, 1891, balance unexpended	$4,839.20
July 1, 1892, balance unexpended	4,839.20

P 6.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adopted in accordance with the recommendations contained in the reports of examinations and surveys of the river, printed in the Annual Reports of the Chief of Engineers for 1872, page 588, and 1889, page 1423.

The project provides for obtaining a low water navigable channel from the mouth of the river to Newton, Ala., an estimated distance of 162 miles, by the removal of logs and snags from the channel and overhanging trees from the banks, by excavating rock shoals, and by deepening sand bars by works of contraction and shore protection.

At Caryville, Fla., 100 miles above its mouth, the river is crossed by the Pensacola and Atlantic Railroad.

The counties along the river below Caryville are sparsely settled, and their business consists almost exclusively in the cutting and rafting of lumber. This portion of the river is so little used for commercial purposes that no work has been done on it for several years past.

Geneva, Ala., 25 miles above Caryville, is a thriving town and is the trading and shipping point for a rich agricultural region surrounding it, which is rapidly increasing in population. Nearly all the commerce of the river is carried on between Geneva and Caryville, the nearest railroad point. During recent years the improvement has consequently been confined mainly to this section of the river. The channel has now been pretty well cleared of the accumulation of snags and logs which formerly obstructed it, but low-water navigation is still impeded by several sand bars. During the coming season it is proposed to begin the deepening of these bars by works of contraction and shore protection, and to carry on this work to completion as funds are available.

Between Geneva and Hollis Bridge, 30 miles above, the river is obstructed by snags and sunken logs, and occasionally by a sand bar.

The obstructions have from time to time been partially cleared out between Geneva and Pate Landing, 25 miles above, and, when freight is offered, steamboats run to Pate Landing at favorable stages of water.

Between Hollis Bridge and Newton, 7 miles above, low-water navigation is prevented by a series of nine shoals, formed by strata of very compact blue clay. Since the completion of the Alabama Midland Railroad, from Montgomery, Ala., to Bainbridge, Ga., which passes through Newton, the urgent necessity for the improvement of this portion of the river no longer exists. It is doubtful if the river would now be much used, even if the improvement were completed. Unless otherwise directed, it is, therefore, not proposed to do any work on the river above Pate Landing, until the section between this point and Caryville has been put in good navigable condition for all stages of water.

After this is accomplished, the annual cost of maintaining a snag boat for the removal of logs and snags brought in by the winter freshets, and for keeping the contraction and shore protection works in repair, is estimated at $6,000.

APPROPRIATIONS.

March 3, 1833	$5,000	March 3, 1881	$10,000
June 15, 1814, for Choctawhatchee and Holmes rivers	10,000	August 2, 1882	18,000
June 23, 1874	5,000	July 5, 1884	15,000
March 3, 1875	5,000	August 5, 1886	15,000
August 4, 1876	5,000	August 11, 1888	10,000
March 3, 1879	5,000	September 19, 1890	12,500
June 14, 1880	7,000	Total	107,500

OPERATIONS TO JUNE 30, 1891.

Operations have been confined almost exclusively to the removal of the great accumulation of logs and snags from the channel, and overhanging trees from the banks, and to providing and maintaining the necessary plant for this work.

The section of the river between its mouth and Caryville having been sufficiently improved to accommodate the small commerce thereon, the work during recent years has been mainly carried on between Caryville and Geneva, but some work has also been done between Geneva and Pate Landing.

The imperfect improvement accomplished has resulted in great benefit to navigation. Steamboats now run at all stages of water between Geneva and Caryville, but at low water full loads can not be carried, and they are much delayed by sand bars, which can be readily deepened if sufficiently large appropriations are made therefor.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer J. E. Turtle, in local charge of the improvement, reports:

At the beginning of the fiscal year a party was at work removing obstructions to navigation under the approved project. This work was continued until December 10, 1891, when, owing to high water, work was suspended and the property stored.

During the high-water months a stern wheel and machinery were put on the snag boat.

On May 24, 1892, work of removing obstructions was resumed.

Work performed was as follows:

Snags removed from channel	2,142
Overhanging trees removed from banks	386
Logs on bank cut up	456
Stumps removed level	4

The alterations made to the snag boat, including machinery and stern wheel, answer the purpose for which they were intended, and will do much to hasten the work.

Many of the snags removed were very large, and had to be broken up with dynamite before they could be handled.

Results.—The work accomplished during the fiscal year ending June 30, 1892, has made possible the passage of boats between Geneva and Caryville during low water without danger, and the passage of rafts on stages 6 inches above low water. During November of 1891 the boats ran at night on a stage 15 inches above low water. This was not due to an increase of depth, but to the removal of very bad obstructions from the channel, making it possible for boats to follow the deep water. No works of contraction have yet been undertaken, and the depths on the various shoal bars is the same, or about 22 inches at very low water.

RECOMMENDATIONS AND ESTIMATES.

I concur in the following recommendations and estimates by Assistant Engineer J. E. Turtle:

The adopted plan calls for the removal of obstructions and for deepening sand bars by works of contraction and shore protection. Up to date work has been confined

to the first requirement of this project, but this is now so far advanced that the deepening of the sand bars can be undertaken.

The plan of improvement, therefore, for the fiscal years ending June 30, 1893, and 1894, will consist, during the first stages of low water, in removing any new obstructions that may have been brought into the channel by freshets, and then in continuing work upon the shoal bars. There will be required each year a certain amount of maintenance work. This will delay the contraction works, with the plant now on hand, and as there are several bars, all requiring improvement, it would be well to increase the plant by building a pile-driver, placing upon this the hoisting engine now at Fort McRee, and the boiler taken from the snag boat. With this plant both classes of work could continue at all times during suitable stages of water, and after the two seasons the work would be so far advanced that the snag boat, with its pile-driver, could keep up with it. With such a plant $30,000 can be profitably expended during the fiscal year ending June 30, 1894.

Money statement.

July 1, 1891, balance unexpended	$12,070.40
June 30, 1892, amount expended during fiscal year	6,748.68
July 1, 1892, balance unexpended	5,321.72
July 1, 1892, outstanding liabilities	829.99
July 1, 1892, balance available	4,491.73
Amount appropriated by act approved July 13, 1892	12,500.00
Amount available for fiscal year ending June 30, 1893	16,991.73
Amount that can be profitably expended in fiscal year ending June 30, 1894	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Capts. J. D. Jenkins and A. F. Tatom, of Geneva, Ala., report the following commercial statistics for the year ending June 30, 1892:

Stern-wheel steamboats.	Registered tonnage.	Draft of water. Light.	Draft of water. Loaded.	Passengers.	Round trips.	Between—
		Inches.	*Inches.*			
Dexter	122.24	24	48	40	70	Geneva and Caryville.
Lena C	34.00	20	40	100	156	Do.
Mary Alice	39.37	16	32	36	67	Do.
					3	Geneva to Pato Landing.

Freight carried.

	Tons.
Cotton, 9,555 bales	2,360
Fertilizers, 31,545 sacks	3,030
Hides, 10 packages	2¼
Live stock, 174 head	65¼
Lumber, 3,500 feet B. M	8
Provisions	2,207
Grain, 16,800 sacks	7,955
Miscellaneous freight	300
Turpentine and rosin, 773 barrels	173
Wool, 98 bales	4¼
Salt, 1,195 sacks	111¼
Total	16,216¾

Estimated value, in round numbers, $1,188,665.

In addition to the steamboat business reported above, a large quantity of logs and sawn and hewn timber is transported to mills on the river, and to the Pensacola market.

It is impracticable to obtain accurate statistics of the lumber business, but the value of the lumber transported by river is estimated at not less than $1,100,100.

P 7.

IMPROVEMENT OF HARBOR AT PENSACOLA, FLORIDA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adopted in accordance with the recommendations contained in the report of the Board of Engineers for fortifications and for river and harbor improvements, dated February 12, 1881, and printed in the Annual Report of the Chief of Engineers for 1881, page 1177.

The project provided for dredging a channel 300 feet wide and 24 feet deep, at mean low water, across the inner bar, for the temporary relief of navigation, and for protecting the shore line near Fort McRee from further abrasion by the construction of jetties and works of shore protection, with the view of preventing further injurious changes in the tidal currents, and also of retaining the position for defensive purposes.

At that time the mean low-water depth on the inner bar was 19½ feet. Between 1881 and 1886 the inner-bar channel was dredged at various times, and in the latter year it was reported that a channel 120 feet wide and 24 feet deep had been obtained.

The further injurious abrasion of the shore line near Fort McRee was stopped by the construction of two groins of stone and concrete, nearly at right angles to the shore line. The groins were completed in April, 1890.

In the spring of 1890 another survey of the entrance to the harbor was made, which showed that the channel across the inner bar had shoaled since 1886 from the reported depth of 24 feet to a depth of 19.6 feet. On January 17, 1891, the report of this survey was referred to a Board of Engineers appointed to assemble at Pensacola, Fla., to consider and report upon the improvement of the harbor. The report of this Board is dated July 16, 1891, and is printed in the Annual Report of the Chief of Engineers for 1891, page 1723.

The plan of improvement recommended by the Board, with the reasons therefor, is sufficiently indicated by the following extracts from their report:

6. CHARACTER OF BAR AND CHANGES.

*   *   *   *   *   *   *

The depth of water on the outer bar since the time of authentic surveys has remained constant at about 22 feet. Previous to the dredging done in accordance with the project of 1881 there was a depth of 19.5 feet across the inner bar. This was increased in 1886 to 24 feet, with a width of 120 feet. The growth of the Middle Ground has caused shoaling to take place in that channel, until there remains at present a low-water depth of 19.6 feet, which is practically that which existed prior to improvement. The depth of water on the three principal shoals has not changed.

7. COMMERCE.

The commerce of Pensacola for the calendar year 1890 amounted to about $5,000,000, the principal exports consisting of cotton, naval stores, timber, and lumber, and the imports of fruit and fertilizers.

Over 300,000,000 feet of timber and lumber were shipped during the year.

Pensacola's foreign sailing tonnage exceeds that of all the other Gulf ports combined, including New Orleans.

Col. W. D. Chipley, vice-president of the Pensacola and Atlantic Railway Company, in reports appended hereto, states that a movement is now fairly started through which Pensacola will export, in addition to the cotton, naval stores, and timber mentioned, coal and iron from the mines of Alabama, railroad, bridge, car, house, and shipbuilding material, etc. He further states that Pensacola is beginning to send cotton goods, machinery, and western produce of every kind to the

Americas south of us, which shipments, he adds, will be largely increased under the policy of reciprocity.

After the deepening of the inner bar in 1881-'86 the commerce of the port was largely augmented, and the class of vessels entering the harbor much improved. Shoaling has since taken place, and during the past year vessels have been detained, after loading, from one to five weeks before being able to go to sea. A number of vessels went aground on the inner bar, while a large number were obliged to put to sea with incomplete cargoes. Owing to the increased commerce of the port the necessity for deep water is greater than before the first improvement was made. It is estimated that a reduction of from 8 to 20 per cent in freight rates would follow an increase of the navigable depth to 26 feet.

It will be seen that Pensacola has better natural conditions for deep water than any other Gulf port. Existing railroads are extending their lines, and new roads, projected or in process of construction, will afford ample facilities for communication with the interior. The importance of Pensacola, from a military and naval standpoint, has long been recognized, and considerations of defense, as well as those governed by commercial necessities, demand the improvement of the entrance to its harbor.

8. PLAN OF IMPROVEMENT.

The method of obtaining deep water across the bar at the entrance to Pensacola Harbor by dredging was tried between 1881 and 1886, there having been obtained in the latter year a channel 120 feet in width and 24 feet in depth.

Although only five years have elapsed since then, the growth of the Middle Ground and Caucus Shoals has been so rapid that the depth of water in the bar channel has already been reduced to that prevailing prior to the original improvement.

To obtain over the inner and outer bars by dredging a channel 24 feet deep and 300 feet wide will cost, in round numbers, $190,000, and will require an annual expenditure of $30,000 thereafter for its maintenance.

A more permanent channel would doubtless be one in the direction of the ebb flow across the outer end of Caucus Shoal, but to obtain this by dredging would cost, in round numbers, $357,000, and its self-maintenance without jetties to insure tidal scour and to protect the channel from the inflow of sand is doubtful.

There remains, then, the method of improvement by jetties, aided, if necessary, by dredging.

The further eastward advance of Caucus Shoal and southward advance of the Middle Ground Shoal should be arrested, and the ebb and flood flow should be united and trained across the bar in a favorable direction.

The location of the western jetty is fixed by the shore line, the present channel, and the direction of tidal flow across the bar. It now becomes necessary to so locate the eastern jetty as not only to arrest the westward travel of sand along the beach of Santa Rosa Island, but to obtain in the jetty channel the greatest tidal scour practicable without injury to the jetties themselves or to the present favorable tidal status of the bay.

* * * * * * *

9. DESCRIPTION OF JETTIES AND ORDER OF CONSTRUCTION.

It is proposed to build the shore arm of the western jetty up to high water; from the shoulder to a point 5,000 feet from the shore end of the jetty the crest should be brought up to the mean height of the beginning of ebb outflow; for the next 4,300 feet the crest should be brought up to mean low water, from which point it will sink to the foundation course.

The shore arm of the eastern jetty should be built up to high water; the crest of the jetty will then sink within a distance of 1,200 feet to the level of the foundation course.

It is proposed to construct the jetties with a foundation course of brush mattresses 100 feet in width, and a superstructure of rubblestone capped with concrete.

* * * * * * *

The estimated cost of the improvement, which, in round numbers, is $1,830,000, supposes that money is regularly and adequately supplied. Without this the cost of the work will be largely increased and its success rendered doubtful. * * *

Under date of August 3, 1891, the report of the Board was referred to the Division Engineer, Southwest Division, for remark. His indorsement was as follows:

Respectfully returned to the Chief of Engineers.

The estimated cost of obtaining 24 feet of water by dredging is $190,000, and its annual maintenance is estimated at $30,000.

The estimated cost of the proposed low jetties is $1,800,000, while the final cost will probably be considerably greater. At 3 per cent the annual interest on $1,800,000 would be $54,900, much exceeding the estimated cost of maintenance of a dredged channel.

In view of these figures, and of the success thus far obtained in the maintenance of the Sandy Hook Channel, I think that the improvement should be continued by dredging, until it is found that $50,000 a year will not maintain a channel after it is once completed.

On November 12, 1891, the Board submitted a supplementary report, in which it is stated:

Inasmuch as the plan of improvement recommended by the Board contemplates an expenditure of $1,830,000, the annual interest on which at 3 per cent ($54,900), exceeds the estimated annual cost of maintenance of the dredged channel, the Board desires to set forth more fully the reasons which compelled the rejection of the plan of improvement by dredging alone, and the substitution of the plan of improvement by jetties.

That a dredged channel across the inner and outer bars at Pensacola will not be self-maintaining has been demonstrated by experience. So few surveys of the bar have, however, been made that it is not possible to determine the rate at which the shoaling has taken place, and therefore for the purposes of estimating the cost of maintaining a dredged channel the rate of shoaling as shown by a comparison of the surveys of 1886 and 1890 was assumed. It is probable, however, that the volume of sand moved in the ship channel during that period was many times that determined by the method outlined. On the South Atlantic coast, at Cumberland Sound, where the bar is composed of material somewhat similar to that at Pensacola, storms of a few days' duration have caused a shoaling of 3 feet and more in the ship channel, while at other times storms of equally short duration have produced as great a scour. It is possible that as great and sudden changes have taken place at Pensacola.

On ocean bars composed of coarse sand or gravel dredging alone has in some instances proved successful, but on the bar at Pensacola, composed of very fine sand, easily placed and held in suspension, no such satisfactory results can be expected. An unjettied channel is moreover liable to be blockaded in a few days or perhaps in a few hours by a heavy storm, while rough weather might prevent dredges from affording relief. If the port of Pensacola is to offer adequate facilities to its shipping, it is imperative that the depth of water on the bar shall not be liable to sudden fluctuations, and the great advantages which would accrue to the shipping by having a permanent and straight channel of probably a greater depth than 24 feet, instead of the present crooked channel with a probable depth during a considerable part of the year of much less than 24 feet, make it necessary that the plan of improvement by jetties should be adopted, and the Board can not therefore recommend a plan of improvement which has already proved a failure, which can at best give only temporary relief, and which may permit the blockade of the harbor during the busiest season of the year, and thus greatly and unnecessarily retard the development of the port and seriously injure its commerce.

APPROPRIATIONS.

June 18, 1878	$20,000	August 5, 1886	20,000
March 3, 1879	10,000	August 11, 1888	35,000
June 14, 1880	40,000	September 19, 1890	25,000
March 3, 1881	20,000		
August 2, 1882	50,000	Total	275,000
July 5, 1884	55,000		

OPERATIONS TO JUNE 30, 1891.

Work has been carried on at intervals since 1879, but at no time has the money available been sufficient to complete the work contemplated by the project. In 1879-'80 the wrecks obstructing the channel were removed. In April, 1890, two stone and concrete groins, for preventing the further abrasion of the shore line at Fort McRee, were completed, and have so far accomplished the purpose for which they were built. Dredging was done at various times between 1881 and 1886, at which time a channel 120 feet wide and 24 feet deep across the inner bar was reported.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer J. E. Turtle, in local charge of the work, reports as follows:

At the beginning of the fiscal year dredging, under the agreement with the suction dredge *Bayley* in June, 1891, had just started. The Government agreed to employ the dredge not less than forty-five days. After being employed from June 28 to July 16, 1891, much of which time was lost, owing to bad weather, she broke her main pump shaft, was recalled to Port Eads, and dredging under this agreement was suspended. Work done by the *Bayley* was confined to the inner bar channel and between the 21-foot curves. The depth over the shoalest portion of this channel area was increased about 1.5 feet, which has since shoaled at least half of this increase.

The total work done by the *Bayley* was as follows:

Cubic yards dredged from inner bar	14,151
Total cost of dredging	$7,839.23
Cost per cubic yard	0.554

Considerable work has been done on the cement tests. Samples have been broken, which now complete the tests of briquettes from one week to over two years old.

RECOMMENDATIONS AND ESTIMATES.

For the reasons given in the foregoing quotations from the reports of the special Board of Engineers, the estimate of $500,000 for beginning the permanent improvement of the harbor by dredging a straight channel across Caucus Shoal and preserving the same by jetties, which was submitted in the Annual Report of the Chief of Engineers for 1891, is renewed.

Money statement.

July 1, 1891, balance unexpended	$25,569.96
June 30, 1892, amount expended during fiscal year	11,380.52
July 1, 1892, balance unexpended	14,189.44
July 1, 1892, outstanding liabilities	325.50
July 1, 1892, balance available	13,863.94
Amount appropriated by act approved July 13, 1892	75,000.00
Amount available for fiscal year ending June 30, 1893	88,863.94
Amount that can be profitably expended in fiscal year ending June 30, 1894	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statement of the business of the port of Pensacola for the fiscal year ending June 30, 1892, is furnished by the collector of customs:

Exports to—	
Foreign ports	$2,982,246.00
Coastwise ports	976,637.00
Total	3,958,883.00
Imports from—	
Foreign ports	64,171.00
Coastwise ports	36,921.00
Total	101,092.00
Duties on imports and miscellaneous collections	27,353.92

Vessels entered from—	
Foreign ports	437
Coastwise ports	133
Total	570
Vessels cleared for—	
Foreign ports	459
Coastwise ports	122
Total	581
Number of vessels employed in traffic of port:	
Steam	28
Sail	128
Total	156

P 8.

IMPROVEMENT OF ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

The Escambia and Conecuh rivers are actually one river, that portion of the river from its headwaters in southeastern Alabama to the Florida and Alabama State line being called the Conecuh River, and the portion in Florida, 61 miles long, being called the Escambia River. It empties into Escambia Bay, which is itself an indentation from Pensacola Bay. Fully 50 per cent of the immense quantity of timber shipped from Pensacola Harbor is cut on lands tributary to the river and is floated down in rafts to Pensacola Harbor.

The present plan of improvement was adopted in accordance with the recommendations contained in the reports of the examinations and surveys of the rivers, printed in the Annual Report of the Chief of Engineers for 1879, pages 843 and 852.

The project provides for the improvement of the river from its mouth to Indian Creek, in Alabama, an estimated distance of 293 miles, by the removal of logs and snags from the channel and overhanging trees from the banks, by excavating rock shoals, by deepening sand bars, by works of contraction and shore protection, and by dredging a channel through the bar at the mouth of the river.

The object of the improvement is to facilitate the movement of saw logs and timber rafts down the river, and to afford at the same time a suitable channel for steamboat navigation. The value of the lumber annually transported on the river is estimated at over $1,500,000.

In order that the rafting business may be carried on safely and profitably, it is necessary that the river should be kept fairly free from logs and snags. This requires the maintenance of an efficient snagboat.

In the fall of 1889 a channel 60 feet wide and 6 feet deep was dredged through the bar at the mouth of the river by means of the centrifugal sand-pump belonging to the snag boat. This channel has since shoaled, and it is very desirable that a sufficient amount should be appropriated to enable a cut 75 feet wide and 8½ feet deep to be made.

The harbor tugs can not now cross the bar and enter the river to reach the rafts and tow them to Pensacola. The rafts are floated

down over the bar and fastened to timber stands in the bay, where they are exposed to sudden storms. A considerable annual loss of lumber and money is thus occasioned.

APPROPRIATIONS.

For Escambia River:		For Escambia and Conecuh rivers:	
March 2, 1833	$5,000	July 5, 1884	$12,000
July 2, 1836	5,500	August 5, 1886	12,000
June 14, 1880	8,000	August 11, 1888	10,000
March 3, 1881	5,000	September 19, 1890	7,500
July 5, 1884	3,000		
August 2, 1882	12,000	Total	80,000

OPERATIONS TO JUNE 30, 1891.

The above appropriations have been expended in providing, maintaining, and renewing the necessary working plant and in removing, to a large extent, the accumulated logs and snags from the channel and overhanging trees from the banks, from the mouth of the river to Thompson Cut-off, a distance of 133 miles; in keeping the channel fairly free from logs and snags brought in by the winter freshets, and in twice dredging a channel through the bar at the mouth of the river to permit the passage of towboats drawing not over 5 feet of water.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer J. E. Turtle, in local charge of the improvement, reports:

At the beginning of the fiscal year a party was at work removing obstructions from the channel as per approved project. Work during the year was confined to that portion of the river lying between Molino, Fla., and Harold Mill, Ala., a distance of 68 miles. Active operations continued until December 16, 1891, when, owing to high water, they were suspended, and the property and plant placed in charge of a watchman. Work was again resumed on May 20, 1892.

Work performed during the year was as follows:

Snags removed from channel	3,523
Overhanging trees from banks	56
Stumps removed, level	144
Logs on banks cut up	1,015
Gravel removed from channel ....cubic yards..	19

Results.—The work accomplished during the fiscal year ending June 30, 1892, has resulted in removing all the bad snags from the channel between Molino and Harold Mill, a distance of about 60 miles, and making the passage of rafts on stages 2 feet above low water practicable and safe over this portion, which was considered to be the worst on the river.

RECOMMENDATIONS AND ESTIMATES.

I concur in the following recommendations and estimates of Assistant Engineer J. E. Turtle:

For some time to come the commerce on this river will be restricted, in my opinion, almost entirely to the transportation of lumber. Therefore that part of the project calling for the improvement of the shoals and bars need not be now attempted, and the removal of obstructions should be directed mainly to providing a safe passage to rafts. The opening of a channel through the bar at the mouth is an important feature of the improvement.

It is expected that the alterations to the snag boat will be made during the present season.

It is recommended that a sufficiently large appropriation may be made for the fiscal year ending June 30, 1894, to enable an 8½-foot channel to be dredged through the bar at the mouth of the river at an estimated cost of $12,000, as well as to continue snagging operations, at an annual cost of $6,000, or of $12,000 for two years.

Money statement.

July 1, 1891, balance unexpended	$7,052.55
Amount received from settlement by Third Auditor of error in account (R. L. Hoxie, captain of engineers, U. S. Army.)	22.41
	7,074.96
June 30, 1892, amount expended during fiscal year	4,403.88
July 1, 1892, balance unexpended	2,671.08
July 1, 1892, outstanding liabilities	521 08
July 1, 1892, balance available	2,150.00
Amount appropriated by act approved July 13, 1892	8,000.00
Amount available for fiscal year ending June 30, 1893	10,150.00
Amount that can be profitably expended in fiscal year ending June 30, 1894 / Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	24,000.00

COMMERCIAL STATISTICS.

Capt. J. S. Stanton reports as follows:

Stern-wheel steamboat.	Registered tonnage.	Draft of water		Round trips from—
		Light.	Loaded.	
		Inches.	*Inches.*	
Eliza Ann	12.54	10	24	Harold Mill to Stokes Landing, 4; Pensacola to Andalusia, 1.

Freight carried.

Fertilizers	tons..	100
Provisions	packages..	100
Grain	sacks..	1,000
Miscellaneous freight	packages..	500
Estimated weight	tons..	142
Estimated value		$5,000

While the steamboat commerce of this river is insignificant, the timber business is very large, amounting in the past year to more than 50 per cent of the entire lumber shipment from Pensacola, or to about 151,000,000 feet, B. M. (252,774 tons), valued in round numbers at $1,510,000.

The maintenance of the river in good rafting condition and the opening of a good channel for tugs through the bar at its mouth are therefore of great value to the commerce of the country.

P 9.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adopted in accordance with the recommendations contained in the report of an examination and partial survey printed in the Annual Report of the Chief of Engineers for 1876, page 498.

The project provides for obtaining a channel 200 feet wide and 4 feet deep at low water from Wetumpka, Ala., to its junction with the Tom-

bigbee River, 44 miles above Mobile, Ala., an estimated distance of 323 miles, by the removal of snags, logs, etc., from the channel and overhanging trees from the banks; removing rock reefs and gravel bars by blasting and dredging, and sand bars by works of contraction and shore protection.

The normal width of the upper portion of the river is from 500 to 600 feet and of the lower portion from 700 to 800 feet. Where the river has the normal width the low-water depths in the channel vary from 8 to 15 feet, but where these widths have been increased by the erosion of the banks, shoals, bars, or reefs are found. The average slope of the low-water surface is about 4 inches per mile. The maintenance of an efficient stern-wheel snag boat is required to remove the logs and snags brought in by the winter freshets each year.

Between 1878 and 1883 the average annual appropriations were $24,000, and with this amount considerable snagging work was done and dikes or jetties built of brush and stone, rock, or pile work and stone, were constructed at eight of the most troublesome bars, viz, The Cut-Off, Haines Island, Hobbs Island, Yellow Jacket, Gardner Island, Hadnot, Cox, and Three Chutes. Since 1883 the appropriations have only sufficed for the maintenance of a snag boat and for annual snagging operations. A great deal of useful work has, however, been accomplished by the removal of logs and snags from the channel and by cutting the overhanging trees. Many of the shoal places in the river are caused by the accumulation of sand and gravel about sunken logs and snags, and a number of the troublesome bars have been permanently improved simply by the removal of these obstructions, without resorting to jetties or dikes.

APPROPRIATIONS.

June 18, 1878	$25,000	August 5, 1886	$15,000
March 3, 1879	30,000	August 11, 1888	20,000
June 14, 1880	25,000	September 19, 1890	20,000
March 3, 1881	20,000		
August 2, 1882	20,000	Total	185,000
July 5, 1884	10,000		

OPERATIONS TO JUNE 30, 1891.

An efficient stern-wheel snag boat had been maintained, and the channel had been kept reasonably free from logs and snags. Previous to 1883 eight of the most troublesome bars were improved by contraction works. Since that date, however, the appropriations have not sufficed for keeping these works in proper repair, and most of them now need renewal.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer C. B. Percy, in local charge of the improvement, reports as follows:

At the opening of the fiscal year of 1891–'92, the crew of the snag boat *Twining* was engaged in cleaning the river above Montgomery to the junction of the Coosa and Tallapoosa rivers. This work was completed in July, when the party was ordered to work over the river from the mouth back to Montgomery, and by October 1 had thoroughly cleared it of all obstructions and overhanging timber from the mouth to Gardner Island, a distance of 230 miles. At this point an attempt was made to remove a portion of the rock jetty at the head of the island, but the bottom of the river below the jetty was found strewn with rocks, and the extreme low stage of the river at that time rendering it dangerous to use the *Twining*, the work was

postponed, and snagging operations were continued toward Montgomery. The river was then lower than it had been in many years, and its navigation between Selma and Montgomery was very much impeded. On November 9 a brush, log, and rock jetty was started across the chute behind Manack Island (18½ miles below Montgomery), at its head, and during the progress of the work a gain of 8 inches in depth was obtained. This work was very near completion when orders were received, November 24, to come up to the "Three Chutes," just below Montgomery, where steamboats were being very much delayed by the scant depth at that point. Work there was commenced November 28, the crest of the bar was raked and a gain of 1 foot in depth was obtained; the middle chute was closed by felling timber into it, and intermingling with the felled timber fascines of brush; a jetty to be of piles, rock, and brush was started December 12 at the head of the upper one of the Three Chutes, but only twenty-nine piles had been driven when the the high-water season set in and the work was finally suspended on December 19. The snag boat *Tallapoosa*, which had been temporarily fitted up as a pile-driver, was towed up to the city, and the *Twining* proceeded down to the mouth of the Cahaba to get the snag boat belonging to that river out of it and bring it to Montgomery, returning to Montgomery December 28. All three boats were then sent on to Big Bend, 17 miles above the city, and on December 30 the crew was discharged and the boats laid up for the season under the charge of two watchmen.

The high-water season of 1891-'92 being about over the boats were ordered to Montgomery April 28, 1892, and the repairs needed on the *Twining* were commenced and were completed May 21. The crew was reorganized and the steamer put in commission May 23, and, after an inspection of the river, snagging operations were commenced May 31 at the mouth.

Due to the three successive high freshets during the winter of 1891-'92 an extraordinary number of large heavy slip-ins occurred all along the river and the banks caved very badly. On account of this extra amount of work, and also to get through the snagging operations as quickly as possible, so as to be ready to commence the proposed permanent improvements, authority was asked for and granted to transfer for the present the Cahaba log boat to the Alabama River to work in connection with the *Wm. J. Twining*. It was towed down to Haines Island, 87 miles above the mouth, June 5, and at the close of the fiscal year ending June 30, 1892, the river from its mouth to Tarver Bar, a distance of 217 miles, had been cleared of all obstructions that were visible at the then prevailing stage of water (3 feet to 6 feet above low water), or could be detected or were reported.

The following is a tabular statement of the work done:

	1891.	1892.	Total.
Overhanging trees felled and cut up	1,531	532	2,063
Overhanging trees pulled back and cut up	582	65	647
Overhanging trees trimmed	64	19	83
Logs on banks cut up	85	27	112
Fallen trees on banks cut up	....	45	45
Stumps on banks cut level	162	8	170
Logs and snags removed from channel	925	37	962
Trees removed from slip-ins	....	277	277
Total	3,449	1,010	4,459

Rock bowlders removed from river	cubic yards..	25
Gravel excavation by raking (estimated)	do....	1,550
Rock and brush jetty built	linear feet..	181
Brush used in jetty	cords..	66
Rock used in jetty	cubic yards..	221
Brush used in closing middle of Three Chutes	cords..	30½

RECOMMENDATIONS AND ESTIMATES.

Should the appropriation of $70,000 provided for in the river and harbor bill now pending in Congress, be made, it is proposed to provide a suitable plant for the expeditious work at the bars which now give trouble at low-water stages. Judging from the satisfactory effects produced by contraction works built between 1878 and 1883, no special difficulty will be experienced in speedily obtaining low-water depths of from 4 to 6 feet on all the bars now having less depths, provided suffi-

ciently large appropriations are made to enable the work to be carried on with an efficient plant and a large working force during the low-water season.

It is estimated that $150,000 can be profitably expended during the fiscal year ending June 30, 1894.

Money statement.

July 1, 1891, balance unexpended	$17,555.78
June 30, 1892, amount expended during fiscal year	10,541.56
July 1, 1892, balance unexpended	7,014.22
July 1, 1892, outstanding liabilities	2,270.76
July 1, 1892, balance available	4,743.46
Amount appropriated by act approved July 13, 1892	70,000.00
Amount available for fiscal year ending June 30, 1893	74,743.46
Amount that can be profitably expended in fiscal year ending June 30, 1894	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR ALABAMA RIVER, ALABAMA.

The following statement of the business done by the steamers named below, during the fiscal year ending June 30, 1892, has been compiled from statements furnished by Capt. James F. Quill, agent of the Alabama River Line of steamers, and by Capt. W. H. Moore, manager of the People's Line of steamers, whose steamers run between Mobile and Montgomery, stopping at intermediate landings; and by Capt. R. Barry, of the steamer *Minnie Lee*, a trading boat plying between Mobile and landings on the lower Alabama River.

Stern-wheel steamboats.	Registered tonnage.	Draft of water.		Between—	Round trips.	Passengers.
		Light.	Loaded.			
		Inches.	*Feet.*			
Nettie Quill	226.93	28	6	Moble and Montgomery	38	6,379
Tinsie Moore	198.29	24	5½	do	51	6,163
Carrier	140.88	18	5	do	14	1,291
Armstrong* / Alto	196.53	18	5	Mobile, Selma, and Montgomery	38	3,142
Minnie Lee	98.00	24	6	Ran in lower river		
Total						16,975

* The *Armstrong* was burned in November, 1891, and the *Alto* took its place.

Freight carried.

	Tons.
Cotton (44,288 bales)	11,072
Cotton seed (114,735 sacks)	6,984
Fertilizers (53,586 sacks)	5,359
Hides and skins (1,200 packages)	250
Live stock (1,187 head)	399
Lumber (213,960 feet)	523
Staves (47,981 pieces)	1,371
Provisions (247,253 packages)	35,322
Grain (88,505 sacks)	7,375
Miscellaneous freight (349,826 packages)	17,491
Total	86,146

Estimated value of above freight, in round numbers, $5,254,906.

In addition to the commerce carried on by boats, the rafting business on the river is very large. Great quantities of sawed and hewed timber and logs are rafted annually, but no available records of this business are kept.

P 10.

IMPROVEMENT OF TALLAPOOSA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

The plan of improvement was adopted in accordance with the recommendations contained in the report of an examination and partial survey of the river, printed in the Annual Report of the Chief of Engineers for 1881, page 1223.

The project provides for obtaining a navigable channel from its junction with the Coosa River, where the two rivers form the Alabama River, to the Tallassee Reefs, 2 miles below Tallassee, the head of navigation, a distance of 48 miles; the channel in open river to be 200 feet in width, with a least depth of 3 feet at low water, and in rock cuts to be 60 feet wide and 3 feet deep at low water; the improvement to be accomplished by the removal of snags, logs, etc., from the channel, cutting overhanging timber from the banks, by excavating rock and gravel reefs, and by deepening sand bars by works of contraction and shore protection.

The river generally presents long reaches of fine, open, navigable water, with a width of 200 to 300 feet and a depth of 6 to 12 feet. When the normal width is exceeded to any extent sand bars and gravel or rock reefs are found, with a low water depth of only 1 to 2 feet. The banks, generally, of the first 30 miles below Tallassee, are firm and stable, but those of the lower river are of soft, unstable material, which yields readily to the eroding action of the river when unprotected by a growth of brush or cane.

The river runs through a continuous succession of rich bottom land, largely cultivated. The adjacent uplands are of good arable soil, with the more hilly portions covered with forests of fine pine timber. The falls at Tallassee furnish magnificent water power, which is now partly utilized by extensive cotton mills. The winter freshets bring large numbers of logs and snags into the channel.

Any improvement effected will require for its preservation the maintenance of a snag boat with its own motive power, the cost of operating which is estimated at $6,000 per year.

APPROPRIATIONS.

August 2, 1882	$15,000
July 5, 1884	10,000
August 5, 1886	7,500
August 11, 1888	7,500
September 19, 1890	4,000
Total	44,000

OPERATIONS TO JUNE 30, 1891.

The appropriations had only sufficed for the building, equipping, and keeping in repair of a snag boat (without motive power), with which snagging operations were carried on during the low-water seasons. The original accumulation of logs and snags was removed from the channel, the most dangerous overhanging timber cut down, and 320 feet of temporary jetty was built. At the close of the season's work in November, 1889, there was a fairly navigable channel for light-draft

steamers from the mouth of the river to Cowle Ferry, a distance of 43 miles.

So far as known no commercial use was made of the improved channel.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer C. B. Percy, in local charge of the improvement, reports as follows:

During August and September the snag boat belonging to this improvement was overhauled and repaired so far as was necessary to put it in good working order, and on October 12 a crew was organized, the boat put into commission and towed to the mouth of the Tallapoosa River, and the ascent of the river by warping was commenced with a view of reaching Zimmerman Reef, 38 miles above the mouth, through which it was contemplated to blast a channel 60 feet wide and 3 feet deep at low water, according to the present project.

The river was found to be so obstructed by the accumulation of logs, snags, etc., of the past two years, and which had to be removed from all the chutes before the boat could pass, that the progress was very slow. The ascent was continued until November 11, when Hallonquest Bar, 4 miles above the mouth, was reached. The chute was found so obstructed, and getting over the shoals so very slow on account of the extreme low water, that the effort to reach the rock reef was abandoned and the party ordered to return to the Alabama River, which was reached November 14. After clearing the obstructions out of the channel at the junction with the Coosa River, the boat was dropped down to Big Bend, 17 miles above Montgomery, on the 18th; and after putting the boat in order the crew was discharged and the boat laid up on November 19, under charge of a watchman.

The obstructions removed were as follows:

Snags removed from the channel	185
Trees pulled back and cut up	47
Trees trimmed	10

Four miles of the river were partially cleared and the obstruction at the junction with the Coosa, which consisted of a very large sycamore and other logs around it, were removed.

RECOMMENDATIONS AND ESTIMATES.

The river and harbor bill now pending in Congress contains no provision for continuing the improvement of the Tallapoosa River. It is presumed that the discontinuance of the improvement is due to the evident indisposition on the part of those interested in having the river opened for commercial use to take any advantage of such improvements as have hitherto been effected. No estimate for continuing the work during the fiscal year ending June 30, 1894, is submitted.

Money statement.

July 1, 1891, balance unexpended	$3,518.72
Amount received from error in settlement account Capt. R. L. Hoxie, Corps of Engineers, U. S. A	52.15
	3,570.87
June 30, 1892, amount expended during fiscal year	2,623.69
July 1, 1892, balance unexpended	947.18
July 1, 1892, outstanding liabilities	61.43
July 1, 1892, balance available	885.75

COMMERCIAL STATISTICS.

In recent years there has been no attempt to run steamboats on this river. The business has been confined to rafting logs and sawed and hewed pine and oak timber. No record has been kept of the business and no reliable estimate of the amount of it can be made.

P II.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

Beginning at Mobile, Ala., the Mobile River, 44 miles long, the Alabama River, 312 miles long, the Coosa River, 315 miles long, the Oostenaula River, 60 miles long, and the Coosawattee, navigable for 45 miles, form, in fact, one great river, which rises in northwestern Georgia, and flows through the mineral fields of North Alabama, the agricultural belt of Middle Alabama, and the timber region of South Alabama.

The Oostenaula and Coosawattee rivers, above Rome, Ga., are navigable for light-draft boats, during nine months of the year, for a distance of 105 miles. Below Rome, the Coosa is navigable during the entire year a distance of 188 miles to Lock No. 4, 3 miles above the Georgia Pacific Railroad bridge. Between Lock No. 4 and Wetumpka, a distance of 116 miles, the navigation of the Coosa River is obstructed by a series of rocky reefs and shoals, separated by stretches of good navigable water, varying in length from one-half to 8 miles. The total fall in the low-water surface of this section of the river is 323 feet. The low-water discharge at Wetumpka is 5,800 cubic feet, the same as that reported for the Mississippi River at St. Paul. Below Wetumpka the Coosa, Alabama, and Mobile rivers afford good navigation during the entire year to tide water at Mobile Bay.

The present plan of improvement was adopted in accordance with the recommendations contained in the reports of the various examinations and surveys, which are printed in the Annual Reports of the Chief of Engineers for 1871, 1872, 1875, 1878, 1881, and 1890.

The project provides for the removal of the lesser rock shoals, and sand and gravel bars, by excavation and by works of contraction, and for the construction of locks and dams to overcome the more serious obstructions.

By the various acts making appropriations the river has been divided into two sections and separate appropriations have been made for each section.

In the upper section, between Rome and the East Tennessee, Virginia and Georgia Railroad bridge, a distance of 236 miles, eight locks, with their accessory dams or dikes, will be required. Of these, three have been completed and the fourth is now under construction. The work is carried on downstream in order that the completion of each lock and dam may immediately open an additional section of the river to the steamboats now running on the upper river.

In the lower section, between Wetumpka and the East Tennessee, Virginia and Georgia Railroad bridge, a distance of 68 miles, twenty-three locks, with their accessory dams or dikes, will be required. The first appropriation for this section of the river was made by the act of September 19, 1890, which required that the work should be commenced at Wetumpka.

1. BETWEEN ROME, GEORGIA, AND THE EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

APPROPRIATIONS.

August 14, 1876	$30,000	July 5, 1884	$50,000
June 18, 1878	75,000	August 5, 1886	45,000
March 3, 1879	45,000	August 11, 1888	60,000
June 14, 1880	75,000	September 19, 1890	150,000
March 3, 1881	60,000		
August 2, 1882	83,700	Total	673,700

OPERATIONS TO JUNE 30, 1891.

The principal obstructions in the channel between Rome, Ga., and Gadsden, Ala., 133 miles, had been removed before this date, and a number of shoals had been improved by wing dams. Navigation had been greatly benefited, and a line of steamboats made regular trips between those points, and extended their trips to Greensport, Ala., 29 miles below Gadsden, and to a landing 1 mile below Lock No. 3, when business demanded it.

Below Greensport, at distances, respectively, of .68, 3.86, and 5.24 miles, three masonry locks, with their accessory dams or dikes, had been completed. These locks had been opened to navigation in February, 1890. Each lock chamber has an available width of 40 feet and length of 175 feet.

WORK DONE DURING PAST FISCAL YEAR.

Lieut. Wm. E. Craighill, Corps of Engineers, U. S. A., who has been in local charge of the improvement of this section of the river during the year, submits the following report:

All work on the river has been done by hired labor. It has been carried on at three principal points, (*a*) Lock 3, (*b*) Lonnergan Reef, (*c*) Lock No. 4.

(*a*) At Lock No. 3, at the beginning of the fiscal year, the work of strengthening and improving the dam was in progress, and early in the summer this work was completed. The improvement made consisted in adding a dry rubble slope on the downstream side and building a low abutment and shore protection of the same character.

The guide crib above the lock, which had already been put in position, was filled with broken stone and the crib below the lock built and filled.

At the foot of Wood Island a rough stone dam 222.5 feet long was built parallel to the channel in order to cut off the current, which at this point swept across the channel.

The following summary gives in tabulated form the details of quantities and cost:

Strengthening dam and building abutment, Lock No. 3.

Class of work.	Quantities.	Cost.	Amount.
	Cu. yds.	*Per cu. yd.*	
Excavating for foundation of dam and abutment (including pumping)	395	$1.44	$568.80
Concreting foundation	12	3.00	36.00
Dry rubble masonry, dam, and abutment	903.26	7.65	6,909.94
Filling behind abutment	645	.41	264.45
Total			7,779.19

(*b*) At Lonnergan Reef a cut 80 feet wide was blasted through the reefs, and the excavated material placed in a low training wall, designed to regulate the current in the channel.

The approach of winter and high water prevented the completion of the channel to the proposed width of 100 feet and depth of 4 feet at low water.

Small timber cribs filled with stone were placed on the training wall to guide boats through the reef.

Channel work at Lonnergan Reef.

Rock excavation (1,096 cubic yards) at $3.56½, $3,907.24.

(*c*) At Lock No. 4, 21 miles below Lock No. 3, the dam was nearly completed; the abutment on the west bank was completed except the coping, and that part of the cofferdam lying above the main dam was completed.

An earthen bank was built on the shore behind the west abutment with its top 6 feet above the highest flood, to prolong the line of the dam to the high ground.

The lock-keeper's house at Lock No. 4 was completed.

Dam No 4 is a crib-work filled with broken stone. The lift is 12 feet, and its total length of crest line 703 feet.

The accompanying drawing shows all details of its construction and dimensions.

To supply the needed stone for the dam, as well as the abutment, a quarry was opened, and a light railway of 3-foot gauge, 1.9 miles long, was built and equipped with locomotive and eight flat cars.

The stone was placed in the dam by means of a cableway across the river. The apparatus was designed to transport loads as great as 8 tons. The stone for the dam was loaded at the quarry by steam derricks into scale boards, or skips, of a cubical capacity of about 3¼ cubic yards. These were placed upon the cars and hauled to a point under the cableway, by which they were raised and carried over the dam, the rock dumped in place, and the empty scale boards returned to the car. The span of the cableway was 1,010 feet. The main cable, of 2¼-inch steel-wire rope, was supported by two skeleton timber towers whose tops were about 100 feet above low water. The motive power was furnished by a large double-drum special hoisting engine placed behind the eastern tower.

Dam No. 4.

Preparing foundation	$588.33
Crib-work in place, including drift bolts (371,005 feet B. M., at $19.20)	7,123.30
Stone filling (7,504.21 cubic yards, at $3.10)	23,263.05
Sheeting face (22,119 feet B. M., at $17.56)	388.41
Total	31,363.09

The details of the abutment for Dam No. 4 are shown in the drawing which is herewith. Borings taken before the excavation was begun indicated that this structure was to be founded on solid rock, but upon further developments the rock under the site proved to be a mere shell of water-worn limestone. Under it were found alternate layers of gravel and clay to an unknown depth. It was therefore necessary to drive piles for the foundation. They were driven to an average depth of about 25 feet below low water, although some went to a much greater depth. All were driven to a bearing in solid material. The piles were cut off at 5½ feet below extreme low water. The exposed face was protected by a row of sheet piling, and riprap in front of the sheeting. The abutment was completed except the coping, no suitable stone being at the time available for the purpose.

The earth embankment, extending 373 feet from the back of the abutment to the high ground, was completed and its end in part protected by stone paving. Bermuda grass has been planted on its sides to protect it from the action of waves. It contains 4,924 cubic yards, costing 30¼ cents per cubic yard.

Masonry abutment, Lock No. 4.

Excavating for foundation, including pumping (3,219 cubic yards, at $1.85)	$5,963.20
Pile foundation (4,860 linear feet, at 14 cents)	680.40
Concreting (310 cubic yards, at $2.94)	911.40
Masonry (backing) (644.79 cubic yards, at $7.90)	5,096.74
Masonry (ashlar) (351 cubic yards, at $18.80)	6,598.80
Sheeting face (9,000 feet B. M., at $20.43)	183.87
Clay filling (2,496 cubic yards, at .23¾)	592.80
Total	20,027.21

So much of the upper end of the cofferdam as was needed to connect the main dam with the shore was finished. The total length of the new part built was 150 feet. Of this 120 feet is about 27 feet high and 30 feet is about 21.5 feet high. One hundred and thirty feet next to the bank had already been built. This was raised 5 feet. The total cost of the work was $6.511.06.

At the beginning of the fiscal year the lock-keeper's house at No. 4 was being built, and was finished in July, 1891.

Lock-keeper's dwelling, Lock No. 4.

Foundation and chimneys	$361.86
Carpentry	2,222.53
Tin work	393.81
Total	3,149.19

Minor works carried on were a survey of the reefs and shoals to be improved between Locks Nos. 3 and 4, and a survey during the winter to determine the exact location of Lock No. 5. The topography of the bank near the proposed site of Lock No. 5 was taken, and discharge observations obtained from 3 feet above low water to about 1 foot above ordinary high water. The computation of the results have not yet been completed, and no final report can yet be made.

Work has been commenced on the cut through the rock reef at Box Shoal, situated just at the head of the pool of Dam No. 4. This is in progress at the date of this report.

RECOMMENDATIONS AND ESTIMATES.

It is almost unnecessary to state that a work of this magnitude can be carried on much more economically and completed at a much less ultimate cost with large appropriations, which will enable the work to proceed without interruption and with efficient plant and a large working force.

Money statement.

July 1, 1891, balance unexpended	$90,315.08
June 30, 1892, amount expended during fiscal year	84,459.31
July 1, 1892, balance unexpended	5,855.77
July 1, 1892, outstanding liabilities	3,480.52
July 1, 1892, balance available	2,375.25
Amount appropriated by act approved July 13, 1892	130,000.00
Amount available for fiscal year ending June 30, 1893	132,375.25
Amount (estimated) required for completion of existing project	960,133.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS, COOSA RIVER, BETWEEN ROME AND EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

Reported by the White Star Line Steamboat Company, the Gadsden Iron Company, and the Lathrop-Hatten Lumber Company. The statistics of the lumber business are not complete. It has not been practicable to obtain a statement of the rafting done by other lumber companies and private individuals.

Stern-wheel steamboat.	Registered tonnage.	Draft of water. Light.	Draft of water. Loaded.	Between—	Round trips.	Passengers.
		Inches.	*Inches.*			
Clifford B. Seay	115.80	19	52	Rome, Ga., and Gadsden, Greensport, Locks 1, 2, and 3, Alabama.	86	1,800
Hill City	87.50	12	48			200
Annie M	58.00	18		Gadsden and Hoke Bluff, Ala.		Towboat.

Freight carried.

	Tons.
Cotton, 17,000 bales	4,250
Cotton seed, 11,000 sacks	550
Fertilizers, 14,000 sacks	1,400
Hides and skins, 250 packages	13
Live stock, 200 head	80
Lumber, 5,000,000 feet	12,500
Staves, 3,000,000 pieces	2,500
Provisions, 30,000 packages	1,800
Grain, 50,000 sacks	2,800
Miscellaneous freight, 50,000 packages	5,625
Rafted logs, 19,000,000 feet, B. M	42,750
Cord wood, 12,000 cords	12,000
Total	86,268

Estimated value of above freights (in round numbers), $1,299,000.

In forwarding statistics the president of the Lathrop-Hatten Lumber Company remarks:

"The completion of the improvement of the Coosa River will open up a vast trade in iron, coal, lumber, cotton, etc. It will be but three days' sail from the Upper Coosa to the Gulf of Mexico at Mobile. We shall be able to compete with the world in prices of coal and iron. A direct competing waterway to the coast will cause a reduction of railroad freight rates, which will give our languishing manufacturing interests an impetus that will last so long as the work shall stand."

2. BETWEEN WETUMPKA, ALABAMA, AND THE EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

APPROPRIATIONS.

September 19, 1890	$150,000

OPERATIONS TO JUNE 30, 1891.

In October, 1890, a party was organized and stationed at Wetumpka to make the detailed surveys necessary for the precise location of Locks Nos. 31, 30, and 29, and to make a series of velocity and discharge measurements at all stages of the river from low to high water. The party was engaged in this work during the remainder of the fiscal year.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Charles Firth, in local charge of the work on this section of the river, reports as follows:

The detailed survey for the location of Lock No. 30, which was begun near the close of the previous fiscal year, was completed, and the work plotted; but the location of the lock and dam will not be finally decided upon until certain data as to the height of overfall caused by permanent dams is obtained from observations to be made at Lock No. 4, after the completion of the dam at that point.

The detailed survey for the location of Lock No. 29 was made, but owing to the subsequent death of the engineer who made the survey, and to pressure of other work, the survey has not yet been plotted.

A survey of Moccasin Reef, which is situated between Locks Nos. 29 and 30, was made, and the work was plotted.

At Lock No. 31, recomputations of the height of overfall over the dam were made, and the location of the lock was finally approved by the Chief of Engineers, July 21, 1891.

Actual construction work at Wetumpka was commenced on September 7, 1891, by diverting the surface drainage, which flowed over the land required for use as a lock yard, and which had washed out a deep gully in the same; this gully has been filled and leveled up from time to time with excavated material from other parts of the works, and a good level yard has been obtained, where the necessary workshops, stables, etc., have been erected.

Owing to the impossibility of obtaining suitable stone in the neighborhood for the masonry of the lock, a report on the comparative merits, feasibility, and probable cost of substituting Portland cement concrete for masonry in the bulk of the work, was prepared and submitted, wherein the cost of such concrete, having a proportion of 1 of cement to 9 of other materials, was estimated at $5.61 per cubic yard, placed in the work.

In view of this important saving over the cost of masonry, it was decided to recommend that the walls be built entirely of concrete up to low-water mark, and above that level to face the concrete with masonry in 12-inch courses, laid in Flemish bond, or header and stretcher alternately.

This plan having been approved by the Chief of Engineers, proposals were asked for by advertisement for the supply and delivery at Wetumpka of about 900 cubic yards of cut stone, this being the quantity necessary for facing the walls of a lock 210 by 40 feet, which was the size specified in the river and harbor bill of 1890. The contract was awarded to Mr. Frank Baldwin, of Birmingham, Ala., the lowest bidder, at $19.93 per cubic yard. The delivery of the stone has only recently been commenced.

An examination of the bars in the Coosa River below Wetumpka, and in the Ala-

bama River above Montgomery, was made, which resulted in the discovery of a large bar of quartz sand at Coosada, about 15 miles below Wetumpka.

Proposals were asked for by advertisement for the construction and delivery of two decked barges to carry the sand from the bar to the site of the works; but all the proposals received were considered to be too high; and, with the approval of the Chief of Engineers, the material was purchased and the barges were built by hired labor. A steamboat has been purchased at New Orleans to be used in towing the barges and for other purposes connected with the improvement. Repairs are now in progress on this boat to better adapt her for her proposed duties.

At the site of the works, an inclined railway has been constructed by which it is proposed to convey the sand in dump cars from the barges to the top of the bank, and there deposit it in a large storage bin already constructed to receive it. As the machinery for operating this railway has not arrived, the storage of sand has not yet commenced.

At the head of the rapids, immediately above the lock, an extensive reef of metamorphic rock projects out from the west bank into the middle of the river, a large portion of which it is necessary to remove in order to straighten the channel; and it is proposed to utilize the harder portions of this rock as broken stone for the concrete required. A plant for breaking and storing this stone has accordingly been erected on the bank immediately above the reef referred to, which will have a capacity for storing about 3,000 tons of broken stone. A No. 3 Gate's rock-breaker, and a double drum hoisting engine have been ordered for this work; but as the latter has not yet arrived, stone-breaking has not been commenced.

The rock excavation in the channel was begun in November, 1891, and all the excavated material has meanwhile been used in leveling up the lock yard, and in the construction of a temporary breakwater to divert the current, which flowed very strongly over the site of the lock, and in which it would have been impracticable to construct the cofferdam.

With the exception of the construction of the two sand barges before mentioned, active operations were suspended for four months during the winter on account of high water.

Statement of cost of work during fiscal year ending June 30, 1892.

Detailed survey and maps for the location of Lock No. 30		$929.02
Detailed survey for location of Lock No. 29		702.12
Detailed survey and map of Moccasin Reef		275.00
Resurvey during extreme low water at Lock No. 31		95.15
Establishment of low-water plane, Locks 6 to 30		198.69
Survey and rent of land at Lock No. 31		84.27
Constructing and recording gauges		218.25
Grading road to site of channel work, earth excavation, 3,829 cubic yards, at 22¼ cents		851.95
Filling and grading lock yard:		
Earth filling, 4,074 cubic yards, at 43 cents	$1,751.82	
Rock filling, 1,953 cubic yards, at 50 cents	976.50	
		2,728.32
Rock excavation in channel, 2,786 cubic yards, at $1.88		5,237.68
Temporary breakwater to protect cofferdam, rock filling, 2,481 cubic yards, at 91 cents		2,257.71
Workshops, stables, sheds, etc		2,007.35
Construction of two sand barges		2,581.86
Inclined railway (440 feet) and sand storage bin		1,295.57
Lock-keeper's house (unfinished)		1,357.05
Cofferdam (unfinished)		616.02
Crushed stone bins (unfinished)		517.86
Cut stone contract (advertising and inspection)		224.13
Machinery, plant, and tools ($5,982 paid for, and $6,329.45 not paid for)		12,311.43
Steamer *Coosada* (purchase, delivery, and repairs)		5,611.00
Sundry repairs to tools and plant		77.79
Care of property during high water		248.05
Engineering and superintendence not properly chargeable to any particular work, office rent, firewood, etc		1,922.54
Bridge and ferry tolls		102.00
Traveling expenses		118.00
Subsistence for employés, and forage for mules		1,003.10
Montgomery office expenses		2,796.16
Total		46,368.07

There is an outstanding liability of $17,339.10 on the contract for cut stone.

RECOMMENDATIONS AND ESTIMATES.

An improvement of this magnitude can be carried on economically and completed within a reasonable time only by the appropriation of sufficiently large amounts to enable the work to proceed without interruption with efficient plant and a large working force.

Money statement.

July 1, 1891, balance unexpended		$141,318.66
June 30, 1892, amount expended during fiscal year		36,582.60
July 1, 1892, balance unexpended		104,736.06
July 1, 1892, outstanding liabilities	$9,785.47	
July 1, 1892, amount covered by uncompleted contracts	17,339.10	
		27,124.57
July 1, 1892, balance available		77,611.49
Amount appropriated by act approved July 13, 1892		100,000.00
Amount available for fiscal year ending June 30, 1893		177,611.49
Amount (estimated) required for completion of existing project		4,843,074.00
Amount that can be profitable expended in fiscal year ending June 30, 1894		600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for two deck barges, delivered at Montgomery, Ala., opened October 3, 1891, at 12 o'clock noon.

No.	Name and address of bidder.	Price per barge.	Delivery.
1	Marshall-Bates Construction Company, Birmingham, Ala	$2,875.00	4 months.
2	William Foster, Mobile, Ala	1,775.00	75 days.
3	Edwin Roney and Benjamin F. Robertson, Mobile, Ala	1,740.00	60 days.
4	P. Blanchard, jr., Scranton, Miss	2,125.00	Do.
5	Seaboard Manufacturing Company, Mobile, Ala	2,438.65	Do.
6	M. A. Sweeney & Bros., Jeffersonville, Ind	1,485.00	Do.

Under date of October 29, 1891, the Chief of Engineers, U. S. A., authorized the rejection of all the above bids as too high, and the building of the barges by hired labor.

Abstract of proposals for supplying cut stone, delivered at Wetumka, Ala., opened October 3, 1891, at 12 o'clock noon.

No.	Name and address of bidder.	Stone.	Net dimensioned stone. Class A, per cubic yard.	Net dimensioned stone. Class B, per cubic yard.	Alternative class. Class A, per cubic yard.	Alternative class. Class B, per cubic yard.	Delivery—commencement after notice.	Completion.
							Days.	Months.
1	Romona Oolitic Stone Co., Indianapolis, Ind.	Oolite limestone.	$29.70	$29.70	$27.00	$27.00	30	*8
2	Gude & Walker, Atlanta, Ga	Granite	39.00	37.00	37.50	35.50	20	6
3	Dark Hollow Quarry Co., Louisville, Ky.	Sandstone	27.25	27.25	27.25	27.25	30	3
4	Southern Supply Co., Birmingham, Ala.†	....do	21.45	20.30	......	......	30	4
5	Georgia Marble Co., Tate, Ga	Marble‡	50.07	47.37½	43.40	40.50	40	12
6	Venable Bros., Atlanta, Ga	Granite	25.10	26.60	23.60	25.60	10	2
7	Jasper Stone Quarry Co., Jasper, Ala.	Sandstone	21.50	20.50	20.50	19.50	40	6
8	Frank Baldwin, Birmingham, Ala§	Granite	19.93	19.93	19.93	19.93	60	6
9	F. G. Power, Lawrenceville, Ga	....do	26.95	24.55	26.40	24.05	30	6
10	Connecticut Steam Brown Stone Co., Portland, Conn.	Brown sandstone.	33.98	33.98	33.95	33.95	30	6

*Season permitting.
†No alternative bid.
‡Sawed stone.
§Contingent on acceptance of entire proposal.

COMMERCIAL STATISTICS.

On March 15, 1887, the Coosa River improvement convention, composed of representative citizens of Alabama and Georgia, and presided over by the governor of Alabama, assembled at Montgomery, and prepared a memorial to Congress.

The memorial contains detailed statistics, and after describing the advantages to be derived from the improvement of the Coosa River, concludes with the following summary:

The Coosa River presents the cheapest and most certain water route to the Gulf of Mexico of the coal, iron, cotton, and cereals of a vast extent of country.

The removal of the obstructions which cut in half this river, now navigable for hundreds of miles below and above such obstructions, is a national duty, in view of the commerce it would pour into the Gulf of Mexico. The opening of the Coosa would enable the Government to move munitions of war from the interior to the seaboard safely and expeditiously.

It would place the navigable waters of the Coosa so close to the navigable waters of the Tennessee that water communication between the two streams must certainly follow, and thus afford the Tennessee River and its vast tributaries an outlet to the Gulf by way of the bay of Mobile.

P 12.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION ON COOSA RIVER, GEORGIA AND ALABAMA.

The expenses of operating and care of Locks Nos. 1, 2, and 3, during the past fiscal year have been paid in the manner indicated by section 4, act of July 5, 1884.

Lieut. William E. Craighill, Corps of Engineers, U. S. Army, has been in local charge of the work, and reports as follows:

During the winter all the locks were pumped out and overhauled.

Repairs were made as follows:

LOCK No. 1.

To the valves.—One frame, 1 box, 2 leaves broken were replaced by new ones.

To the gates.—All the maneuvering ropes renewed. One leaf of the upper gate which had been damaged by a boat striking it, was repaired with bolts. Some minor repairs were made to the maneuvering machinery, and to the lock-keeper's house. All silt collected in the lock chamber was cleared out. Bermuda grass and shade trees have been set out by the lock-keeper in the yard.

LOCK No. 2.

To the valves.—One frame and 2 leaves broken were renewed; 1 valve lever fitted with experimental notched arc and spring latch, designed to prevent the valve from breaking by closing violently under pressure.

To the gates.—All maneuvering ropes were renewed.

To the masonry.—The coping of the lower miter sill was found to have been lifted by the upward pressure of the gates. The sill was taken up and concrete 4 feet thick laid under it. The bolts of the sill were securely fastened in the concrete. All silt was removed from the lock chamber, and the bottom was leveled up with concrete where it had been scoured out by the inflow at the upper culverts. Minor repairs were made to the lock-keeper's dwelling.

LOCK No. 3.

To the valves.—One leaf renewed.

To the gates.—One maneuvering rope on the lower gate renewed. The lock floor was leveled up with concrete where scoured out by the inflow at the upper culverts. Minor repairs were made to the lock-keeper's house. The levee and the yard were repaired after the April freshet, and Bermuda grass was set out.

The experimental latch on the valve lever at Lock No. 2 was found to be a success, and similar ones have been ordered for all the valves of three locks. These are modeled from the latch on the reverse lever of a locomotive engine, and operate successfully to prevent the valves from closing violently, and make it possible to set the valves at any desired amount of opening.

Some stones were placed on the top of Dam No. 1. These had been knocked off by drift or by the action of floods. The total cost was $70.25.

As required by law, the following statement of expenditures is submitted:

Statement of amount expended during the fiscal year ending June 30, 1892, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair Locks Nos. 1, 2, and 3, Coosa River, Georgia and Alabama.

Lock No. 1:		
Lock-keeper's salary, twelve months, at $50	$600.00	
Repairs to dam	70.25	
Repairs to valves and gates	973.16	
Fencing and gates	77.00	
Paints and oils	8.96	
Two safety latches for valve levers	50.00	
		$1,779.37
Lock No. 2:		
Lock-keeper's salary, twelve months, at $50	600.00	
Repairs to valves and gates	577.64	
Excavating and concreting foundation lower miter sill	1,985.38	
Fencing and gates	41.00	
Paints and oils	8.96	
One safety latch for valve levers	25.00	
		3,237.98
Lock No. 3:		
Lock-keeper's salary, twelve months, at $50	600.00	
Repairs to valves and gates	682.89	
Cutting overhanging trees	106.88	
Repairs to levee and house	45.21	
Paints and oils	8.95	
Fencing and gates	53.00	
Four safety latches for valve levers	100.00	
		1,596.93
Total		6,614.28

P 13.

IMPROVEMENT OF CAHABA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

The present plan of improvement was adoped in accordance with the recommendations contained in the reports of surveys and examinations printed in the Annual Reports of the Chief of Engineers for 1875, page 11, and for 1881, page 1232.

The project contemplates obtaining a navigable channel from its mouth to the town of Centerville, a distance of 88 miles, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, excavating the soft rock and gravel bars, and deepening sand bars by works of contraction and shore protection; the channel to be 3 feet deep at low water, 100 feet wide in open river, and 60 feet wide through the bars.

Above Centerville the river is a series of pools and rapids, having a

fall of 109.2 feet in 21 miles. This portion of the river passes through the extensive Cahaba coal fields, but can only be made navigable by a system of locks and dams. Below Centerville the river is a series of pools and rapids, having a fall of 127.4 feet in 88 miles.

The act of August 5, 1886, appropriated $7,500 for continuing the improvement, but with the proviso that "no part of said sum shall be expended until the officer in charge shall have reported that the railroad and other bridges crossing said river have been provided with good and suitable draw-openings." No changes had in the meantime been made in the bridges, but the act of September 19, 1890, provided that "the existing provision restricting the expenditure of the balance now available for the improvement of said river is hereby repealed, and said balance shall be expended in continuing the improvement thereof."

APPROPRIATIONS.

August 2, 1882	$20,000
July 5, 1884	10,000
August 5, 1886	7,500
Total	37,500

OPERATIONS TO JUNE 30, 1891.

The appropriations to June 30, 1886, amounted to $30,000, and with this amount it had been practicable to build and equip a moderately efficient working plant and to improve the river, according to the project adopted, from the mouth to a point below the bridge of the Alabama Central Division of the East Tennessee, Virginia and Georgia Railroad, a distance of about 19½ miles, and to make a partial improvement of the river to Centerville, for high-water navigation, by cutting overhanging timber.

During the fiscal year ending June 30, 1891, the construction of a light-draft log boat, suitable for snagging operations on the river, was begun and nearly completed.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer C. B. Percy, in local charge of the improvement, reports as follows:

The log boat was completed July 21, 1891; a crew, after some unavoidable delay, was organized, and the boat was dropped down to Wallace Ferry, about 54 miles above the mouth of the river. At that point work was commenced, and continued until September 5, when, on account of the small balance on hand, the party was turned back and ordered to push as rapidly as possible to the mouth or junction with the Alabama River; but, owing to the low stage of the river during the entire fall (it being 1¼ feet lower than ever known before), the progress was very slow and difficult, and finally the work was suspended on November 4, party discharged, and the boat laid up about 5 miles above Fike Ferry, under charge of the watchman, to await a rise in the river. It was finally brought out December 25, towed up to Big Bend, 17 miles above Montgomery, and laid up with the plant belonging to the Alabama and Tallapoosa rivers. No further work has been done on this improvement, due to the appropriation being very nearly exhausted.

During the working season the following obstructions were removed:

Number of overhanging trees felled and cut up	17
Number of logs on bank cut up	6
Number of stumps (cypress) blown up from channel	1
Number of snags, trees, and logs removed from channel	1,613
Linear feet of bank cleared of brush	300
Cubic yards of gravel excavated by scraping	277
Linear feet of willow jetty constructed	1,558

Length of river comparatively cleared of obstructions from Wallace Ferry to Brock Bend, 12½ miles upstream, and river partly worked over from Wallace Ferry to Brush Creek, about 12 miles downstream.

RECOMMENDATIONS AND ESTIMATES.

It is not known whether the river would be used by steamboats for commercial purposes provided the bridges now obstructing it were changed to drawbridges and the river was sufficiently cleared of logs, snags, and overhanging trees to permit navigation. Several inquiries have been made by steamboat men as to the character and feasibility of its navigation.

If the improvement is to be continued, $20,000 can be profitably expended during the fiscal year ending June 30, 1894.

Money statement.

July 1, 1891, balance unexpended	$4,263.79
June 30, 1892, amount expended during fiscal year	4,184.02
July 1, 1892, balance unexpended	79.77
July 1, 1892, outstanding liabilities	8.70
July 1, 1892, balance available	71.07
Amount appropriated by act approved July 13, 1892	7,500.00
Amount available for fiscal year ending June 30, 1893	7,571.07
Amount that can be profitably expended in fiscal year ending June 30, 1894. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

COMMERCIAL STATISTICS.

No steamboats have navigated this river for many years past, and but few barges. The entire cotton crop of this section was formerly flatboated down the Cahaba to the Alabama River; but of late years, owing to its bad condition, very little cotton or other produce has thus been carried to market.

A large amount of sawn and hewn timber and saw logs of oak, cypress, and pine is annually rafted out of the river via the Alabama River to Mobile, but no record of any sort is kept of this business and no reliable estimate of its amount can be made.

APPENDIX Q.

IMPROVEMENT OF CERTAIN RIVERS IN ALABAMA AND MISSISSIPPI, OF BOGUE CHITTO, LOUISIANA, AND OF HARBORS AT MOBILE, ALABAMA, AND BILOXI, MISSISSIPPI.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mobile Harbor, Alabama.
2. Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek.
3. Warrior and Tombigbee rivers, Alabama and Mississippi.
4. Noxubee River, Mississippi.
5. Pascagoula River, Mississippi.
6. Chickasahay River, Mississippi.
7. Bluff Creek, Mississippi.
8. Leaf River, Mississippi.
9. Harbor at Biloxi Bay, Mississippi.
10. Pearl River, Mississippi, below Jackson.
11. Pearl River, Mississippi, between Carthage and Jackson.
12. Pearl River, Mississippi, between Edinburg and Carthage.
13. Bogue Chitto, Louisiana.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., July 16, 1892.

GENERAL: I have the honor to forward herewith annual reports * * * for the fiscal year ending June 30, 1892, for the following works under my charge.

* * * * * * *

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major, Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q 1.

IMPROVEMENT OF HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of the harbor at Mobile, Ala., was begun by the General Government in 1827, the depth of water then being $5\frac{1}{2}$ feet through Choctaw Pass and 8 feet on Dog River Bar.

The following appropriations were made by act of Congress:

May 20, 1826	$10,000.00
March 2, 1829	20,000.00
June 24, 1834	10,000.00
March 3, 1835	17,997.60
March 3, 1837	50,000.00
July 7, 1838	50,000.00
August 3, 1852	50,000.00
	207,997.60
By act of Congress, March 3, 1857 (relief claim)	20,833.08
Total	228,830.68

The result obtained was a channel 10 feet deep and 200 feet wide through the pass, and the same depth with an unknown width over the bar. In 1860 the channel through the pass was found to have shoaled to 7½ feet, the depth of water on the bar remaining the same.

No further improvement was attempted until 1870.

From 1870 to 1875 the following amounts were appropriated for the purpose of obtaining a depth of 13 feet:

By act of Congress—	
July 11, 1870	$50,000
March 3, 1871	50,000
June 10, 1872	75,000
March 3, 1873	100,000
June 23, 1874	100,000
March 3, 1875	26,000
Total	401,000

This amount was expended in dredging a channel 13 feet deep and 300 feet wide from the mouth of the Mobile River through Choctaw Pass, and 13 feet deep and 200 feet wide through Dog River Bar to the 13-foot curve in the bay. The work was completed in 1876, and the channel remained practically as it was dredged until operations were commenced under a new project to obtain a depth of 17 feet. In 1878 a survey was directed to be made in order to determine whether the existing channel could be improved to a depth of 22 feet, and for this purpose Congress, by act of June 18, 1878, appropriated the sum of $10,000.

The survey was made and a report was submitted to the Chief of Engineers, suggesting several plans of improvement. In March, 1880, it was decided to continue the former improvement by dredging to a depth of 17 feet, with a uniform width of 200 feet from the 17-foot curve in the Mobile River to the curve of the same depth in the lower bay, the estimated cost being $820,000. From 1878 to June 30, 1887, the following amounts were appropriated:

By act of Congress—	
June 18, 1878 (survey)	$10,000
March 3, 1879	100,000
June 14, 1880	125,000
March 3, 1881	100,000
August 2, 1882	125,000
July 5, 1884	200,000
August 6, 1886	90,000
Total	750,000

Statement of work done under the above appropriations.

Date of act.	Name of contractor.	Contract price measurement in scow.	Cubic yards removed.	Commenced.	Completed.
		Cents.			
Mar. 13, 1879 / June 14, 1880	George C. Fobes & Co.	12.3	1,610,804	Feb. 19, 1881	Nov. 9, 1832
Mar. 3, 1881	G. L. Long	11.7	724,730	Mar. 21, 1882	Jan. 24, 1884
Aug. 2, 1882	R. Moore	12.3	888,093	Jan. 24, 1883	Feb. 9, 1884
July 5, 1884	Tobias Burke	9.0	1,920,438	Sept. 19, 1884	June 15, 1886
Aug. 6, 1886	R. Moore	9.5	829,854	Oct. 2, 1886	Apr. 25, 1887
	Total		5,973,919		

The channel of 17-foot depth was opened to a width of 75 feet in 1882 and was widened to 180 feet in 1889, and practically completed.

During this time vessels passed through with a maximum draft of 18 feet, but owing to a filling in the cut at the lower end the draft was generally limited to 16 feet.

February 6, 1885, a project was submitted for the improvement of Mobile River and Harbor, with a view of securing 23 feet depth of water by enlarging and deepening by dredging the channel, which, since 1870, had been deepened in that manner, first from 9 to 13 feet, and then from 13 to 17. The estimated cost of the 23-foot project, with extension made by act of September 19, 1890, is $2,043,800, made up as follows:

Completion of 17-foot channel (including removal of material filled in cut) upon which estimate for 23-foot cut was based	$282,000
Dredging channel 280 feet wide on top of cut and central depth of 23 feet	1,500,000
Removing material that will fill in during progress of work on 23-foot channel (during three years)	198,000
Dredging channel in Mobile River up to Chickasabogue 280 feet wide and 23 feet deep	63,800
Total	2,043,800

To which must be added $60,000 per year after June 30, 1891, for removing material that will fill in during the progress of the work.

From August 11, 1888, to the end of this fiscal year the following appropriations have been made:

By act of Congress—	
August 11, 1888	$250,000
September 19, 1890	350,000
Total	600,000

Under the appropriation of $250,000, made by act of August, 1888, work was commenced in October, 1888, and continued to the middle of February, 1890, at which time a cut had been made 80 feet wide and from 19 to 20 feet deep from Mobile to where that depth practically existed in the lower bay.

Under the appropriation of $350,000, made by act of Congress of September 19, 1890, work was commenced on January 1, 1891, and continued to the end of the fiscal year June 30, 1892.

Statement of work done under above appropriations.

Date of act.	Name of contractor.	Contract price, measured in scows.	Cubic yards removed.	Commenced.	Completed.	Plant.
		Cents.				
Aug. 11, 1888	Alabama Dredging and Jetty Company.	9	2,312,295	Oct. 15, 1888	Feb. 17, 1880	2 clam-shell dredges, 4 scows, 2 tugs.
Sept. 19, 1890	National Dredging Company.	8¾	3,060,619	Jan. 1, 1891	May 2, 1892	3 clam-shell dredges, 8 scows, and 4 tugs.
Do	Alabama Dredging and Jetty Company.	15	395,691	July. 1, 1891		1 clam-shell, 2 scows and 1 tug.

Tabular statement showing the channel as dredged and its condition June, 1892.

Locality.	Dredged 1881-1892.				Examinations.				
	From the initial point.	Length between clusters.	Width.	Central depth.	Cross section at—	Top width.	June, 1890. Maximum depth in cross section.	June, 1891. Maximum depth in cross section.	June, 1892. Maximum depth in cross section.
	Miles.	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*
Initial point at mouth of Mobile River or Chain Cluster No. 1.	......	......	145	23-24	Chain Cluster No. 1.	620	21.4	20.4	26.2
Chain Cluster No. 1 to Chain Cluster No. 2.	0.06	330	145	23-24	Chain Cluster No. 2.	530	21.6	19.3	26.3
Chain Cluster No. 2 to Upper Gap Light Stake.	0.45	2,080	145	23-24	Upper Gap Light Stake.	700	20.5	21.5	25.9
Upper Gap Light Stake to Cluster No. 2.	0.64	978	245	23-24	Cluster No. 2	700	21.9	21.6	28.0
Cluster No. 2 to Chain Cluster No. 3.	1.07	2,259	155	23-24	Chain Cluster No. 3.	700	20.4	23.0	26.8
Chain Cluster No. 3 to Lower Gap Light Stake.	1.48	2,182	155	23-24	Lower Gap Light Stake.	700	20.3	20.0	28.0
Lower Gap Light Stake to Cluster No. 3.	1.96	2,565	145	23-24	Cluster No. 3	700+	22.2	20.5	27.3
Cluster No. 3 to Cluster No. 4..	2.46	2,603	145	23-24	Cluster No. 4	700+	20.2	26.2	26.0
Cluster No. 4 to Cluster No. 5 .	3.25	4,194	145	23-24	Cluster No. 5	700+	20.6	28.0	26.7
Cluster No. 5 to Cluster No. 6 .	8.50	1,338	145	23-24	Cluster No. 6	709+	20.8	26.5	26.7
Cluster No. 6 to Cluster No. 7 .	4.02	2,735	145	23-24	Cluster No. 7	700+	18.8	23.5	23.9
Cluster No. 7 to Cluster No. 8 .	4.59	2,998	145	23-24	Cluster No. 8	700+	19.6	26.7	25.2
Cluster No. 8 to Cluster No. 9 .	5.09	2,654	145	23-24	Cluster No. 9	700+	20.2	28.0	26.3
Cluster No. 9 to Cluster No. 10.	5.61	2,713	145	23-24	Cluster No. 10	700+	20.8	18.6	25.5
Cluster No. 10 to Cluster No. 11.	6.11	2,655	145	23-24	Cluster No. 11	700+	19.0	18.4	25.5
Cluster No. 11 to Cluster No. 12.	6.60	2,610	145	23-24	Cluster No. 12	700+	19.0	17.8	25.5
Cluster No. 12 to Cluster No. 13.	7.08	2,501	145	23-24	Cluster No. 13	700+	19.3	18.2	23.5
Cluster No. 13 to Cluster No. 14.	7.54	2,418	145	23-24	Cluster No. 14	700+	19.4	18.1	25.8
Cluster No. 14 to Cluster No. 15.	8.03	2,625	145	23-24	Cluster No. 15	700+	19.3	18.2	25.6
Cluster No. 15 to Cluster No. 16.	8.54	2,666	145	23-24	Cluster No. 16	700+	19.3	17.9	26.5
Cluster No. 16 to Cluster No. 17.	9.03	2,591	145	23-24	Cluster No. 17	700+	19.2	17.6	24.0
Cluster No. 17 to Cluster No. 18.	9.52	2,582	145	23-24	Cluster No. 18	700+	19.1	17.8	23.7
Cluster No. 18 to Cluster No. 19.	10.01	2,616	145	23-24	Cluster No. 19	700+	19.0	17.9	25.5
Cluster No. 19 to Cluster No. 20.	10.52	2,659	145	23-24	Cluster No. 20	700+	19.7	18.0	23.5
Cluster No. 20 to Cluster No. 21.	11.00	2,580	145	23-24	Cluster No. 21	700+	20.5	18.2	24.1
Cluster No. 21 to Cluster No 22.	11.41	2,550	145	23-24	Cluster No. 22	700+	19.6	17.8	23.5
Cluster No. 22 to Cluster No. 23.	11.99	2,590	145	23-24	Cluster No. 23	700+	19.2	17.8	23.0
Cluster No. 23 to Cluster No. 24.	12.45	2,502	145	23-24	Cluster No. 24	700+	19.5	17.2	24.0
Cluster No. 24 to Cluster No. 25.	12.94	2,560	145	23-24	Cluster No. 25	700+	19.2	17.4	23.5
Cluster No. 25 to Cluster No. 26.	13.42	2,535	145	23-24	Cluster No. 26	700+	18.7	17.1	22.6
Cluster No. 26 to Cluster No. 27.	13.91	2,592	145	23-24	Cluster No. 27	700+	18.2	17.2	21.8
Cluster No. 27 to Cluster No. 28.	14.40	2,592	145	23-24	Cluster No. 28	700+	18.4	17.0	21.3
Cluster No. 28 to Cluster No. 29.	14.99	2,587	145	23-24	Cluster No. 29	700+	17.9	17.1	22.6
Cluster No. 29 to Cluster No. 30.	15.39	2,620	145	23-24	Cluster No. 30	700+	18.3	16.7	23.0
Cluster No. 30 to Cluster No. 31.	15.91	1,790	145	23-24	Cluster No. 31	700+	17.2	16.1	28.0
Cluster No. 31 to Cluster No. 32.	16.21	2,580	145	23-24	Cluster No. 32	700+	17.7	16.3	23.0
Cluster No. 32 to Cluster No. 33.	16.71	2,650	185	23-24	Cluster No. 33	700+	17.4	16.4	22.0
Cluster No. 33 to Cluster No. 34.	17.24	2,750	185	23-24	Cluster No. 34	700+	16.7	16.0	22.6
Cluster No. 34 to Cluster No. 35.	17.75	2,725	185	23-24	Cluster No 35	700+	17.3	20.1	21.9
Cluster No. 35 to Cluster No. 36.	18.27	2,750	185	23-24	Cluster No. 36	700+	16.6	23.7	21.8
Cluster No. 36 to Cluster No. 37.	18.77	2,615	185	23-24	Cluster No. 37	700+	15.9	24.5	21.7
Cluster No. 37 to Cluster No. 38.	19.25	2,540	185	23-24	Cluster No. 38	700+	16.5	23.2	23.7
Cluster No. 38 to Cluster No. 39.	19.76	2,695	185	23-24	Cluster No. 39	700+	16.6	23.3	24.6
Cluster No. 39 to Cluster No. 40.	20.27	2,705	185	23-24	Cluster No. 40	700+	15.9	23.2	24.8
Cluster No. 40 to Cluster No. 41.	20.69	2,227	185	23-24	Cluster No. 41	700+	16.2	20.7	22.4
Cluster No. 41 to Cluster No. 42.	21.29	3,160	185	23-24	Cluster No. 42	700+	15.8	19.7	23.1
Cluster No. 42 to Cluster No. 43.	21.83	2,824	185	23.24	Cluster No. 43	700+	15.6	14.7	24.8
Cluster No. 43 to Cluster No. 44.	22.33	2,660	185	23-24	Cluster No. 44	700+	16.7	14.9	20.6
Cluster No. 44 to Cluster No. 45.	22.94	3,230	185	23-24	Cluster No. 45	700+	17.8	15.4	21.9
Cluster No. 45 to Cluster No. 46.	23.35	2,145	185	23-24	Cluster No. 46	700+	17.5	15.4	21.7
Cluster No. 46 to Cluster No. 47.	23.89	2,865	185	23-24	Cluster No. 47	700+	17.9	16.1	20.2
Cluster No. 47 to Cluster No. 48.	24.40	2,701	185	23-24	Cluster No. 48	700+	18.3	16.1	22.4
Cluster No. 48 to Cluster No. 49.	24.94	2,833	185	23-24	Cluster No. 49	700+	19.5	17.0	24.2
Cluster No. 49 to Cluster No. 50.	25.49	2,930	185	23-24	Cluster No. 50	700+	20.4	17.7	25.7
Cluster No. 50 to Cluster No. 51.	25.91	2,210	185	23-24	Cluster No. 51	700+	18.6	17.8	25.5

Five hundred thousand dollars annually is the least amount that can be used in a successful prosecution of the work.

Money statement.

July 1, 1891, balance unexpended		$293,319.68
June 30, 1892, amount expended during fiscal year		275,198.23
July 1, 1892, balance unexpended		18,121.45
July 1, 1892, outstanding liabilities	$11,871.34	
July 1, 1892, amount covered by uncompleted contracts	4,478.80	
		16,350.14
July 1, 1892, balance available		1,771.31
Amount appropriated by act approved July 13, 1892		212,500.00
Amount available for fiscal year ending June 30, 1893		214,271.31
Amount (estimated) required for completion of existing project		1,231,300.00
Amount (estimated) required for preservation of improvement		120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Description.	Entries— 1892. No.	Entries— 1892. Tons.	Entries— 1892. Crew.	Entries— 1891. No.	Entries— 1891. Tons.	Entries— 1891. Crew.	Clearances— 1892. No.	Clearances— 1892. Tons.	Clearances— 1892. Crew.	Clearances— 1891. No.	Clearances— 1891. Tons.	Clearances— 1891. Crew.
Foreign	156	108,190	2,107	137	87,781	1,778	164	121,229	2,309	149	100,001	1,772
Coastwise	151	100,235	2,789	130	78,187	2,184	134	82,300	2,322	71	37,955	895
American	68	23,890	503	45	15,601	331	80	28,321	595	60	21,071	481
Total	375	232,315	5,399	312	181,569	4,293	378	231,850	5,226	280	159,027	3,448

Imports and exports.

Description.	1892.	1891.
Duties on imports	$7,949.72	$7,560.67
Tonnage dues	6,429.42	4,945.50
Hospital collections	328.00	552.50
Miscellaneous	1,418.39	1,255.60
Total collections	16,125.53	14,314.27
Exports to foreign ports	2,790,014.00	3,309,308.00

Comparative statement of timber, lumber, etc., shipped to foreign and coastwise ports.

Description.	1892.	1891.	1890.	1881.
Lumber:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Foreign	51,217	40,054	87,364	15,375
Coastwise	24,838	31,123	11,792	12,783
Total	76,055	71,177	99,156	28,158
Timber:				
Foreign	73,527	62,292	33,992	27,101
Coastwise				1,744
Total	73,527	62,292	33,992	28,845
Cross-ties, piles, and poles:				
Foreign	4,551			
Coastwise	1,909			
Total	6,460			

Comparative statement of timber, lumber, etc.—Continued.

Description.	1892.	1891.	1890.	1881.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Shingles:				
Foreign	585	129	135	866
Coastwise	1,350	19	154	480
Total	1,935	148	289	1,346
Staves:				
Foreign	189	111	504	831
Coastwise	192	83	....	....
Total	381	194	504	831

The following is a comparative statement of the number and character of vessels of greater draft than 13 feet which have passed through the dredged channel during the fiscal years ending June 30, 1891 and 1892.

Draft in feet.	Steamers.				Ships.				Barks.				Brigs.				Schooners.				Total.			
	Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.	
	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1892.	1891.	1802.	1891.	1892.	1891.	1892.	1891.	1802.	1901.
13 to 14	54	5	4	7	7	4	...	...	46	18	4	...	...	1	5	2	...	2	15	9	107	30	28	18
14 to 15	3	3	51	53	2	2	...	...	10	16	3	2	...	...	2	1	5	3	34	21	20	24	90	77
15 to 16	4	...	4	3	1	1	...	1	1	6	6	7	...	...	...	4	...	4	22	22	6	11	32	37
16 to 17	1	...	2	10	1	...	9	7	...	1	45	66	1	...	1	1	...	3	6	14	3	4	63	98
17 to 17½	...	...	4	6	...	...	1	...	1	2	10	3	...	...	...	1	...	...	2	3	1	2	17	13
17½ to 18	...	...	2	1	...	...	1	...	...	...	13	2	...	...	...	...	...	...	...	...	...	...	16	3
18 to 19½	...	...	1	...	...	...	...	...	...	...	6	...	...	...	...	...	...	...	...	...	...	...	7	...
Total	62	8	68	80	11	7	11	8	58	43	87	80	1	1	8	9	5	12	79	69	137	71	253	246

NOTE.—The apparent discrepancy in the numbers of vessels arriving and departing is explained by the fact that many craft come up the channel drawing less and go down drawing more than 13 feet. Of vessels drawing less than 13 feet, 285 have passed up and 108 have gone down the channel during the past fiscal year.

Q 2.

IMPROVEMENT OF BLACK WARRIOR RIVER, ALABAMA, FROM TUSCALOOSA TO DANIELS CREEK.

Act of May 23, 1828, declared Black Warrior River, Alabama, free from all tolls except such as might be allowed by act of Congress (sec. 5244, Revised Statutes, edition of 1878, page 1015).

An examination and partial survey of the river from Locust Fork to Tuscaloosa, 47½ miles, was made in 1874, in accordance with provisions of act of Congress approved June 23, 1874, report of which is contained in Report of Chief of Engineers, 1875.

A survey of the river from forks of Sipsey and Mulberry, 92¼ miles, was made in the fall of 1879, as directed by act of Congress approved March 3, 1879.

The report thereon is contained in Report of Chief of Engineers, 1881, Part II, page 1218.

Appropropriations have been made as follows:

By act of—	
July 5, 1884	$50,000
August 5, 1886	56,250
August 11, 1888	100,000
September 19, 1890	150,000
Total	356,250

Under the first appropriation a survey for locating works of improvement and for obtaining data upon which to base detailed plans and estimates was commenced in September, 1884, and a report proposing a system of improvement by locks and movable dams was submitted December 19, 1885.

A Board of Engineers for considering the report and project met in Tuscaloosa February 10, 1886, and recommended a change to locks and fixed dams of increased lift.

Plans and estimates prepared in accordance with the recommendation were submitted August 13, 1886, and, with slight modifications, were accepted by the Board in their report of April 2, 1887. The project was approved May 19, 1887. The extent of the work is the construction of five locks and dams, with a total lift of 52 feet, between Tuscaloosa and Daniels Creek, 14¾ miles, and its purpose is to furnish slackwater navigation for barges of 6 feet draft.

The locks are to be 52 feet clear width, 322 feet long between hollow quoins, available length 285 feet, and to have a depth of 6½ feet on miter sills, and are to have iron gates. The dams are to be of rock-fill type. The estimated cost was $741,670, which will be probably exceeded, as the rock used in construction is found, both in quarrying and working, more expensive than was anticipated.

Work was commenced in March, 1888, and has been carried on continually since, with the exception of a suspension from September 1 to October 20, 1890, caused by exhaustion of funds.

The land required on the east side of the river for Lock No. 1 was deeded to the United States by mayor and board of aldermen of the city of Tuscaloosa, Ala., in November, 1887.

For the fiscal year ending June 30, 1888, the work done was preparatory, viz, clearing and grading lock site, building necessary sheds and quarters, commencing track to quarry, stripping quarry, etc. A lock tender's house, to serve as Engineer's office during construction, was contracted for and completed in May, at a cost of $1,990.

During the fiscal year ending June 30, 1889, the preparatory work was finished, comprising 1¾ miles of track to the quarry, two inclines into the lock chamber, forming a circuit for delivering stone, cofferdam 7 to 12 feet high and 550 feet long completed, 19 derricks framed and put up, bank excavation for lock walls finished, and a derrick boat and two barges built.

The work of construction proper during the year was:

	Cubic yards.
Stone quarried	7,811
Stone cut	2,364
Stone laid	1,434
Rock excavation in foundation	816
Earth excavation in foundation	1,500

During the fiscal year ending June 30, 1890, the work done was:

Masonry laid	yards..	7,262
Dry masonry laid	do....	248
Stone cut	do....	950

Stone quarried	yards..	4,100
Rock excavated in lock chamber	do....	1,541
Earth excavated for bank wall	do....	3,780
Rock placed in dam	do....	800
Rock placed behind bank wall	do....	600
Earth placed behind bank wall	do....	941
Trestles for needle dam constructed	do....	5

The rock reef on which the lock rests was found so much cut by crevices that it was found necessary to carry lock, miter, and needle-dam walls down to the bottom of the lock chamber, thereby increasing the amount of masonry 1,390 yards over the estimate.

During the fiscal year ending June 30, 1891, the work done was as follows:

Funds having become nearly exhausted at the close of the last fiscal year, the work in July and August was confined to completing the masonry of Lock No. 1, and was then suspended until October 20, at which time a new appropriation became available.

Upon resuming work it was found necessary to renew the outfit to some extent. New booms and braces were required for the derrick and a new road to the works, to avoid trespassing upon private grounds. The track to the quarry had also to be relaid with steel rails. This track had originally been a wooden one with a strap rail, for mule service, the supposition at the time being that the haul would not exceed a mile in length, but in reaching out for better quarry facilities it finally became 2 miles long, a distance for which economy required the use of a locomotive and steel track. In addition to these changes and renewals, which were made during the fall and winter, the coffer-dams for Locks Nos. 2 and 3 were put in with the inclines 3,000 feet long leading down to them.

The quarry heretofore used had been an expensive one to work and only a small force could be advantageously employed on it. It was desirable to get one capable of a larger monthly output and at less cost per yard. Explorations failed to indicate a better site along the river bank, and it was finally determined to quarry rock from the river bed. Accordingly in building the cofferdam for No. 3 it was made long enough (1,300 feet) to inclose an area of 7 acres, open at the lower end, where there is an abrupt fall of 4 feet, so that the inclosure drains itself.

Other work for the year is itemized as follows:

Stone quarried, ashlar	cubic yards..	846
Stone quarried, backing	do....	2,600
Stone cut	do....	1,038
Masonry laid	do....	567
Paving foot of bank	square yards..	2,040
Turfing bank slope	do....	3,132
Rock excavation in lock pit	cubic yards..	1,255
Earth filling behind wall	do....	1,900
Rock filling behind wall	do....	1,800
Sand hauled for mortar	do....	850

During the fiscal year ending June 30, 1892, was as follows:

Lock No. 1:		
Rock used in bank revetment and dam	cubic yards..	960
Additional paving	square yards..	440
Lock No. 2:		
Rock excavated in foundation	cubic yards..	891
Earth excavated in foundation	do....	1,902
Ashlar quarried	do....	2,790
Backing quarried	do....	685
Masonry laid	do....	6,121
Stone cut	do....	2,600

Lock No. 3:

Ashlar quarried	yards..	356
Backing quarried	do....	325
Stone cut	do....	57

PRESENT CONDITION OF THE WORK.

Lock No. 1.—Lock-tender's house built and occupied as an engineer office. Lock masonry completed. Base of dam filled in to within 9 feet of the crest. Lock yard paved and bank sloped and turfed and steps laid. The stone are on hand prepared for the abutment and dam.

Lock No. 2.—The river wall is completed; 1,341 yards of masonry have been laid in the bank wall and the stone for finishing it is in readiness.

Lock No. 3.—Cofferdam built and 356 yards of ashlar quarried. The foundation for the lock walls is being excavated.

It is estimated that $200,000 expended in the next two years will complete the work covered by the first three locks and dams. This will open up about 10 miles of river and render accessible a large area of 3-foot and 4-foot coal seams.

Many of these have been opened and occasionally worked, but only for local consumption, owing to lack of transportation facilities. They will undoubtedly become largely productive as soon as the river can be utilized.

Deed for site of Lock No. 2 was obtained by purchase from the Tuscaloosa and Castle Hill Real Estate and Manufacturing Company. Deed for site of Lock No. 3 was granted by the trustees of the State University. Deed for site of abutment for Lock No. 1 was obtained by condemnation.

COMMERCIAL IMPORTANCE.

The completion of the project now in progress will extend the navigable waters of the Warrior River into the chief mineral region of Alabama (known as the Birmingham district), giving it a water outlet to the Gulf. The first result anticipated is the development of the coal seams adjacent to the river. Under the favorable conditions for mining that exist and the low cost of barge transportation it is estimated that the output of these mines can be profitably marketed in Mobile Bay at $1.25 per ton. At this price the Warrior mines could practically monopolize the coal business of the Gulf, both for local consumption and for export, and the coal tonnage on the river would be so great as, of itself, to justify the cost of river improvement; but it seems quite probable that the coal business would not be the only or even the most important one to be developed by the improved river; that to be derived from other mineral resources must be considered.

The present annual output capacity of Jefferson County, in which Birmingham is situated, is estimated in round numbers as follows:

	Tons.
Coal (daily capacity, 14,000)	5,000,000
Coke	1,300,000
Iron ore	2,700,000
Pig iron (daily capacity, 2,500)	900,000

The works producing the above output can readily be connected with the Warrior by short extensions of existing railways, and future iron and steel plants, with the river opened, would doubtless be placed on or adjacent to the river banks. At present the Birmingham furnaces have to market their products in the North and West, and the cost of

transport over the long rail route by which these markets are reached offsets to a great extent the exceptional advantages that these furnaces possess for cheap production. Moreover, the Birmingham products, by increasing so largely the stocks in the Northern markets, have tended to reduce prices, and doubtless have intensified, if they have not caused, the depression that has prevailed in the iron industries during the past two years. Hence a water route, opening new markets to the Birmingham iron trade, would benefit not only that trade, but the iron industries of the whole country.

Should the Nicaragua Canal be opened the Birmingham furnaces, rolling-mills, and steel plants will find their best and most cheaply accessible markets along the Pacific coast via the Warrior River and the Nicaragua Canal. Naturally their products will move in that direction.

Money statement.

July 1, 1891, balance unexpended	$108,578.51
June 30, 1892, amount expended during fiscal year	76,783.43
July 1, 1892, balance unexpended	31,795.08
July 1, 1892, outstanding liabilities	6,197.47
July 1, 1892, balance available	25,597.61
Amount appropriated by act approved July 13, 1892	200,000.00
Amount available for fiscal year ending June 30, 1893	225,597.61
Amount (estimated) required for completion of existing project	185,420.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	185,420.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 3.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

WARRIOR RIVER.

The examination and partial survey of the river from Tuscaloosa to Demopolis was made in 1874, and report thereon may be found in the Report of the Chief of Engineers of 1875, Part II, page 16.

In its original condition the river was well adapted for high-water navigation, having a width of 400 feet at Tuscaloosa, gradually diminishing to 150 feet near its mouth. The boating stage usually lasted five months, from December 1 to May 1, the depth ranging from 10 to 40 feet, and the only obstructions encountered were overhanging trees, which sometimes carried away chimneys of steamboats and damaged their upper works. Below a 10-foot stage snags became troublesome, and below 5 feet navigation practically ceased.

The obstructions to low-water navigation were: (1) Ninety-four bars and reefs that afforded a ruling depth of 12 to 30 inches; (2) numerous snags and sunken logs, choking up the bar chutes and frequent in the reaches also; (3) overhanging trees that effectually closed narrow chutes, even if otherwise open.

The improvement of the Warrior was authorized by act of Congress of March 3, 1875, and the project adopted was to deepen the bars by jetty construction, remove snags, and cut down overhanging trees, with a view to obtaining for small boats a low water channel 80 feet wide by 4 in depth.

The estimated cost of the improvement was $105,103. Appropriations were made as follows:

Warrior and Tombigbee rivers:	
March 3, 1875	$25,000
August 14, 1876	15,000
June 18, 1878	28,000
March 3, 1879	20,000
Warrior River:	
June 14, 1880	20,000
March 3, 1881	10,622
August 2, 1882	10,000
July 5, 1884	12,000
August 5, 1886	18,750
August 11, 1888	18,000
September 19, 1890	45,000
Total	222,372

Of this amount, $134,372 was appropriated for the Warrior, and $88,000 for Warrior and Tombigbee jointly.

The execution of the project was commenced in June, 1875, and continued for an average annual period of four months up to November 10, 1885, and for three months in 1887, the work being confined chiefly to the removal of snags and overhanging trees. Channel deepening by jetty construction was also attempted upon 49 of the bars affording the shoalest water.

The work in 1887 was done by contract. The work of removing snags and logs has been repeated several times over a great part of the river. This has been made necessary from the fact that landslides and caving banks every year throw many trees into the river that, anchored by their roots, obstruct the channel. This trouble will continue until stability shall have been given to the yielding banks. The work of sloping and revetting needed for this purpose was not originally contemplated, but as the necessity for it became apparent an experimental section 3,000 feet long was tried in 1886, costing at the rate of $6,000 per mile, which proved satisfactory.

The practical results accomplished under the above project may be stated as having lowered the navigable stage 3 feet, a boat with 600 bales of cotton and drawing 4½ feet passing down the river without difficulty on a stage barely 2 feet above low water.

Better results than this could not be expected in continuing the old project, because the slope on portions of the river is such that the low-water discharge will not give a uniform depth of more than 2½ feet in a channel 80 feet wide. Moreover, the statement as to the results obtained holds good only in the fall, because the low-water chutes around the bars lie out of the current during high water, and consequently fill up. The scouring-out process does not keep pace with the fall of the river surface in the spring, and it is not until late in the summer that the chutes become fully opened.

It was therefore evident that to secure a 4-foot low-water channel of navigable width a new project had to be adopted, and when the improvement of the Black Warrior River above Tuscaloosa was undertaken for the benefit of the recently developed mineral business of the Upper Warrior it was evident that the 6-foot low-water depth adopted in that project should be extended throughout the river below.

A survey of the Warrior was authorized from Tuscaloosa to the mouth, in order to get the data necessary for preparing plans and estimates for the improvements of the river on scale desired.

The survey was commenced in the summer of 1887 and completed in the fall of 1889, and a report was submitted December 24, 1889, proposing a plan of improvement to obtain a good channel with a minimum depth of 6 feet at low water by a system of dams and pnuematic gates in connection with snagging, cutting of overhanging trees, bank revetment, and bar improvement, at an estimated cost of $577,000.

Since that time a more careful study of the data obtained by the survey has resulted in a change in the views previously entertained and a belief that locks in similar size and general construction to those above Tuscaloosa will be better than the pneumatic gates.

The work during the fiscal year ending June 30, 1891, was confined to a preparation of a portion of a suitable plant for future use in the improvement of the river, the old plant having been completely used up, and an attempt to do the work by contract having resulted in the conviction that it was more economical and advantageous to do the work by day's labor.

The following is a statement of work performed during the fiscal year ending June 30, 1892.

Work on the improvement of this river was commenced at Forrest Bridge Piers on December 1, 1891, and carried down to the mouth, suspended December 23, 1891, on account of high water, resumed early in March, 1892, at Choctaw Bluff, Ala., suspended during the latter part of March, 1892, on account of high water, and resumed in May, 1892.

Snags pulled, cut up, and removed	757
Number of cuts made	652
Slip-ins removed	4
Drifts removed, piles	16
Stumps blasted and removed	8
Logs blasted and removed	1
Logs on bank cut up	52
Number of cuts made	133
Overhanging trees felled, pulled back, and cut up	384
Number of cuts made	1,886
Trees trimmed	15
Bushes cut	694

Money statement.

July 1, 1891, balance unexpended	$37,127.13
June 30, 1892, amount expended during fiscal year	26,831.01
July 1, 1892, balance unexpended	10,296.12
Amount appropriated by act approved July 13, 1892	75,000.00
Amount available for fiscal year ending June 30, 1893	85,296.12
Amount (estimated) required for completion of existing project	457,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Articles.		1892.	1891.
Cotton	tons	1,480	1,500
Grain	do	675	685
Iron	do	20	21
Lumber	do	25	5
General merchandise	do	1,753	1,815
Total		3,933	4,026

TOMBIGBEE RIVER, FROM WALKERS BRIDGE TO FULTON.

The examination of this section of the Tombigbee River was provided for by the river and harbor act of March 3, 1881, and again by the river and harbor act of August 5, 1886. An examination was made under the first act and a report was submitted February 10, 1882, which is contained in the Annual Report of the Chief of Engineers for 1882.

Under the second act reference was made to the examination previously made.

For the improvement of this section of the river the river and harbor act of—

August 11, 1888, appropriated	$4,000
September 19, 1890, appropriated	4,000
Total	8,000

The projected improvement was the opening of a channel for high-water navigation from Fulton up to Walkers Bridge by the removal of snags and overhanging trees at an estimated cost of $11,000.

Work was commenced at Fulton on November 17, 1888, and continued to December 21, 1888, when work was suspended on account of high water. It was resumed as soon as the stage of water would permit, March 15, 1889, and continued to the middle of August, 1889. Work under appropriation of $4,000, made by act of September 19, 1890, was commenced in January, 1891, at Stevens Field and carried on until a rise of the river caused suspension on February 4, 1891, and resumed again in March, and Walkers Bridge was reached in May 16, 1891.

On account of high water during March, April, and May, 1891, considerable necessary work had to be passed over; it was deemed best to return downstream and go over the work again while the water was low. The party working downstream reached Fulton on the 30th of June, 1891, and completed the projected improvement.

The improvement made will not be permanent, but, owing to caving banks and shifting of channels, will require reworking from time to time.

The following obstructions were removed during the fiscal year ending June 30, 1891:

Trees pulled	454
Trees cut	2,886
Logs removed	1,085
Drifts removed	4
Stumps removed	640

The results obtained by the improvement are as follows:

Rafts of timber of much larger size than formerly can be floated down without breaking them up as was formerly necessary on a stage of 3½ feet above low water, and barges 80 feet long, 22 feet beam, and 4 feet draft can be used when the water is 5 feet above low water.

It is estimated that the saving in freight and expense of transportation on cotton and timber and other supplies will be not less than $12,000 annually.

The length of this section of the river as given in the report of the preliminary examination (25 miles) is much too small.

Money statement.

July 1, 1891, balance unexpended	$1,482.82
June 30, 1892, amount expended during fiscal year	1,073.93
July 1, 1892, balance unexpended	408.89
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,408.89
Amount (estimated) required for preservation of improvement	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1892.	1891.
Lumber ... tons	8,250	3,000
Staves ... do	28	125
Total	8,278	3,125

TOMBIGBEE RIVER FROM FULTON TO VIENNA.

A survey of that portion of this section of the river from Fulton down to Columbus, 144 miles, was made under the act of June 10, 1872, and report of same submitted September 20, 1873. This report is contained in the Annual Report of the Chief of Engineers for 1873.

An examination was made of the remaining portion, 65 miles, under the act of July, 1870, report of which is contained in Annual Report of the Chief of Engineers for 1871.

Previous to improvement navigation was carried on only during the winter (high-water) season, and was seldom attempted above Aberdeen, 112 miles below Fulton. Snags, sawyers, and stumps obstructed the channel, in low stages, so that navigation practically ceased on a stage 6 feet above low water below Columbus, and 12 feet above. Overhanging trees were troublesome at all stages and frequent cause of damage. The normal width of the river on a navigable stage was from 80 feet at Fulton to 150 at Vienna. The project adopted for this division was to improve high-water navigation from Fulton to Columbus by removing all timber obstructions above the low-water plane, and to clear the banks of overhanging trees from Columbus to Vienna. Besides clearing the river bed and banks of obstructions, it was proposed to deepen the bars by dikes and jetties, so as to increase the depth of them (12 inches to 13 inches) 3 feet, with a width of 40 feet.

The estimated cost of the improvement of the entire river was $205,000.

The amounts appropriated for this division and specially designated in appropriations made for the Warrior and Tombigbee have been:

By act of—		By act of—	
March 3, 1873	$10,000	August 2, 1882	$7,500
June 18, 1878	12,000	July 5, 1884	10,000
March 3, 1879	10,000	August 5, 1886	7,500
June 14, 1880	16,000	August 11, 1888	6,500
March 3, 1881	7,365	September 19, 1890	6,000

Work was commenced in August, 1878, and continued annually during a portion of each year until May 12, 1888.

The work accomplished has been as follows:

From Fulton to Columbus the project has been completed as designated, and navigation secured down to a stage 4 feet above low water. Below Columbus 5,130 snags, stumps, and sunken logs have been removed, overhanging trees cut, and 20 bars deepened to 3 feet, leaving 15 unimproved. The effect of the improvement has been to afford a navigable channel from Columbus to Vienna for boats drawing 3 feet with the river 2 feet above low water. Another foot can be gained by improving the unworked bars on the plan heretofore adopted, but the results obtained from the deepened bars show that they will not generally maintain the 3 feet required, and a 2-foot low-water channel is all that can be expected from the scouring method heretofore used.

The cost of maintaining the improved condition would be about $8,000 annually.

A survey of the river from Columbus to Vienna was made in 1887, and report with project and estimates for a channel of 6 feet depth at low water was submitted December 24, 1889.

Work during the year ending June 30, 1891, consisted in the preparation of part of a plant for future operations, and the commencement of work of improvement at Fulton, June 30, and at Aberdeen, June 15, 1891, both forces working down, and at Vienna, June 28, 1891, this force working up toward Columbus.

During the fiscal year ending June 30, 1892: Work commenced in June, 1891, by one party from Aberdeen, Miss., up, and improved 52 miles. A second party commenced July 1, at Fulton, Miss., and improved 50 miles downstream. Work suspended September 30, 1891.

Snags cut up and removed	2,317
Cuts made	630
Stumps leveled and blasted	803
Cuts made	261
Sunken logs cut up	157
Cuts made	249
Logs on bank cut up	1,400
Cuts made	5,379
Overhanging trees felled, pulled back, and cut up	4,101
Cuts made	8,086
Bushes cut	6,305
Willows cut, yards	375
Jetties repaired	4

Money statement.

July 1, 1891, balance unexpended	$4,714.26
June 30, 1892, amount expended during fiscal year	4,714.26
Amount appropriated by act approved July 13, 1892	6,000.00
Amount (estimated) required for preservation of improvement	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1892.
Lumber	8,250

TOMBIGBEE RIVER FROM ITS MOUTH UP TO DEMOPOLIS.

Survey of this portion of river was directed by the act of August 11, 1888.

Report upon the survey was submitted December 24, 1889. The project proposed was to obtain a channel of 6 feet depth at ordinary low water by the removal of snags, logs, and overhanging trees, dredging, bank revetment, and the construction of locks and dams.

The length of this section of the river to be improved is 191 miles.

The estimated cost is $508,808.

By the act of September 19, 1890, an appropriation was made of $55,000 for this work.

Operations during the fiscal year ending June 30, 1891, consisted in the preparation of a plant, most of which was completed, and the full improvement of the river, according to the project, from the mouth up, 65 miles, and the partial improvement of 37½ miles more.

Operations during the fiscal year ending June 30, 1892, were as follows: Commenced July, 1891, suspended in November, 1891, on account of high water, and resumed June 1, 1892. Operations were commenced at Millers Gin, 44½ miles above the mouth, in removing snags, logs, trees, etc., as far as Barneys Shoals, 156 miles above the month. The old jetties at Osage and Barneys shoals were repaired.

From June 1 to June 30, 1892, snags, logs, trees, etc., were removed from Demopolis, Ala., 12 miles downstream.

The improvement of McGrews Shoals, Alabama, 63 miles, Woods Bluff 101 miles, and Pearsons Shoals 128 miles above the mouth, by blasting and rock excavations, was commenced.

The following is a statement of work performed:

Snags pulled, cut up, and removed	584
Number of cuts made	1,396
Stumps blasted, leveled, and removed	16
Logs on bank cut up	15
Overhanging trees felled, pulled back, and cut up	511
Number of cuts made	852
Bushes cut	693
Old jetties repaired ... linear feet	1,585
Rock blasted and excavated ... cubic yards	2,944½
Sunken barges removed	3

An annual appropriation of $10,000 will be required for the preservation of this improvement of the river, and should be made separately from the appropriation for the work proper.

Money statement.

July 1, 1891, balance unexpended	$45,351.02
June 30, 1892, amount expended during fiscal year	38,538.87
July 1, 1892, balance unexpended	6,812.15
Amount appropriated by act approved July 13, 1892	125,000.00
Amount available for the fiscal year ending June 30, 1893	131,812.15
Amount (eststimated) required for completion of existing project	328,808.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	328,808.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1892.
Cotton .... tons..	9,560
Grain .... do...	7,084
Iron .... do...	71
Lumber and cross-ties .... do...	41,866
Shingles .... do...	1,146
General merchandise .... do...	17,709
Total	77,376

TOMBIGBEE RIVER FROM DEMOPOLIS, ALABAMA, TO COLUMBUS, MISSISSIPPI.

Extending improvement to secure 6 feet draft at low water. The survey of this section of the river was directed by the act of August 11, 1888.

Report upon the survey was submitted December 24, 1889. The project proposed was to obtain a channel of 6-feet draft by the removal of logs, snags, and overhanging trees, bank revetment, bar improvement by contraction works, and dams and locks, at an estimated cost of $779,400.

The length of this portion of the river is 156 miles.

An appropriation was made by the act of September 19, 1890, of $15,000.

Operations during the fiscal year ending June 30, 1891, consisted in the preparation of a plant for the work. Work was commenced during June.

During the fiscal year ending June 30, 1892, work was suspended December 23, 1891. Twenty-two and one-half miles from Windham down were cleared of snags, logs, and overhanging trees, and the remainder of the time was devoted to removing sunken obstructions at Ten Mile Shoals, 10 miles below Columbus. Work performed—

Snags pulled, cut up, and removed	1,018
Cuts made	244
Stumps leveled, blasted, and removed	1,499
Cuts made	199
Sunken trees pulled, cut up, and removed	110
Cuts made	435
Logs on bank cut up	1,007
Cuts made	3,753
Overhanging trees felled, pulled back, and cut up	7,406
Cuts made	18,581
Trees deadened	39
Trees trimmed	197
Brushes cut	4,383

The amount of $20,000 should be made available each year for the removal of the yearly accumulation of snags, slip-ins, etc., on the Warrior and Tombigbee rivers (including all the divisions).

An annual appropriation of about $28,000 will be required for the preservation of the improvement.

Money statement.

July 1, 1891, balance unexpended	$14,712.00
June 30, 1892, amount expended during fiscal year	14,712.00
Amount appropriated by act approved July 13, 1892	35,000.00
Amount (estimated) required for completion of existing project	729,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.		1892.
Cotton	tons	3,000
Grain	do	2,916
Iron	do	29
Lumber	do	5,833
General merchandise	do	7,291
Total		19,069

Q 4.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

The examination of this river, provided for by act of Congress approved March 3, 1879, was made during the month of March, 1880, and extended from Macon, Noxubee County, Miss., to its mouth.

Report is contained in the Annual Report of the Chief of Engineers for 1880. The condition of the river when examined was such that during all seasons of the year and at all stages of water, navigation, except by small flatboats, was practically impossible.

Steamboats, prior to the building of the Mobile and Ohio Railroad (1859), plied the river. After the construction of this railroad the boats were withdrawn. The river banks then became overgrown with timber, much of which in time fell or slid into the river, and caused the formation of a number of shoals and bars. The river being virtually abandoned for the purpose of navigation, the planters living along its banks assisted in obstructing its channel way by building a number of fish traps and milldams. The chief obstruction to navigation consisted in the immense number of trees overhanging the river throughout its entire length.

At the time of the examination the minimum depth of the river was found to be (at ordinary low water) 1½ feet and the average width 60 feet.

The project adopted was to afford a navigable channel during high water, or about five months, to the town of Macon, by the removal of overhanging timber from the banks and such obstructions to navigation might be found in the river.

The estimated cost was $65,245.25.

The appropriations made for the improvement are as follows:

By act of Congress—	
June 14, 1880	$12,000
March 3, 1881	8,000
August 2, 1882	10,000
July 5, 1884	7,500
August 5, 1886	7,500
By act of Congress—	
August 11, 1888	$5,000
September 19, 1890	3,000
Total	53,000

Work was commenced on the improvement during the low-water season of 1880, prosecuted during the fiscal years ending June, 1881, and June 30, 1882, and through the month of March, 1883; from September, 1884, to January 12, 1885; from May 23, 1885, to September 23, 1885; from May 26, 1887, to December 15, 1887; from May 15, 1888, to July 20, 1888; from September 20, 1888, to December 8, 1888; from April 1, 1889, to October, 1889. The condition of the improvement at the end of the fiscal year is a completely improved channel from the mouth of the river up to Macon, 91½ miles, and the project may be considered to be

completed. The amount available, and any appropriation that may be made, will be applied to the maintenance of improvement.

The river during high water is navigable from its mouth to Macon.

This work will require an annual expenditure of $3,000 to maintain it in its improved condition, and no further improvement should be considered until the Tombigbee River below Gainesville is completely improved.

The reduction in freight charges on cotton and produce by railroad, due to the improvement of the river, is estimated at not less, and probably much more, than $20,000 per annum.

Money statement.

July 1, 1891, balance unexpended	$3,257.46
June 30, 1892, amount expended during fiscal year	156.75
July 1, 1892, balance unexpended	3,100.71
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	6,100.71
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Q 5.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

By act of—

March 2, 1827, an appropriation was made of	$8,000
May 23, 1828, an appropriation was made of	17,500
August 30, 1852, an appropriation was made of	5,000

The first appropriation was made for removing obstructions from the river and deepening the channel at its mouth, the second one was made for deepening the channel at its mouth, and the third was made for a survey of the river. There are no records in this office of the work done under these appropriations.

In 1870, March 1, a canal (called Noyes Canal) dredged across the bar at the mouth of the river, under a charter from the State of Mississippi to Abram A. Green, to a depth sufficient to admit vessels of 6 feet draft at low tide, was opened by private parties.

The cost of the canal was stated to be $27,000, and for annual maintenance $4,000.

By the act of March 3, 1873, a survey was directed to be made at East Pascagoula Harbor, Mississippi Sound. This survey was made during the same year, and report was submitted October 23, 1873. The report is contained in the Annual Report of the Chief of Engineers for 1874. The plan adopted for the improvement was the dredging of a channel 200 feet wide and 7 feet deep at mean low water through the bar at the mouth of the river, and the removal of snags and overhanging trees throughout its entire length, at an estimated cost of $53,800.

The following appropriations were made to carry out this project:

By act of—	
June 18, 1878	$10,000
March 3, 1879	14,000
June 14, 1880	20,000
March 3, 1881	4,000
August 2, 1882	$8,000
July 5, 1884	3,000
Total	59,000

At the commencement of the work there was 3 feet on the crest of the bar at mean low water, and the river was much obstructed by snags, logs, and overhanging trees. Of the aggregate amount of the several appropriations made up to July 5, 1884, less $1,500 allotted for examination, $42,500 was devoted to dredging through the bar at the mouth, and resulted in securing a channel through the bar 180 feet to 190 feet wide, 7½ to 8 feet deep.

Fifteen thousand dollars of the amount appropriated up to that time was applied to the removal of snags, logs, and overhanging trees. Commencing at the light-house near the mouth of the river, in the spring of 1882, the work was prosecuted during the working season of 1882, 1883, and 1884. This portion of the work was completed on December 23, 1884, and resulted in securing a navigable channel from the mouth of the river to one-half mile above "Dead Lake," 50½ miles, for vessels drawing 6½ feet, and to the junction of the Leaf and Chickasaha for vessels of lighter draft, during six or eight months of the year. The project was then virtually completed.

By act of—

August 5, 1886, an appropriation was made of	$20,000
August 5, 1886, transferred amount appropriated for improving Horn Island Pass, act of July 5, 1884	5,000
August 11, 1888, an appropriation was made of	27,000
September 19, 1890, an appropriation was made of	20,000
Total	72,000

Under these appropriations a new project was proposed and approved for securing a channel of navigable width and minimum depth of 12 feet from Moss Point to the anchorage in the bay, at an estimated cost of $78,100 and maintaining the river above Moss Point in its improved condition.

After due advertisement bids for dredging were opened August 17, 1887, and contract entered into with J. H. Gardner, September 15, 1887.

Dredging operations were commenced October 8, 1887, and completed April 28, 1888, 113,529 cubic yards were removed. The wreck of the United States snag boat, sunk opposite Moss Point, was removed during May, 1888. Bids for improving Pascagoula River, Mississippi (dredging and building dam), were received and opened November 27, 1888, but prices (17½ cents for dredging and $3,700 for dam) were not satisfactory, and all were rejected.

Bids were again solicited and opened January 20, 1890, and that of George C. Fobes & Co., for dredging at 16.2 cents per cubic yard, and the Alabama Dredging and Jetty Company, for the dam, $3,350 accepted and contracts entered into.

Dredging was commenced April 16, 1890, and continued to the latter part of July, 1890. The dam was completed in July, 1890.

Bids were solicited and opened November 20, 1890, and the lowest, that of the Alabama Dredging and Jetty Company, at 22 cents per cubic yard, measured in the scow, accepted and contract entered into.

Dredging was commenced in February, 1891, and continued to September 25, 1891.

Under the contract with George C. Fobes & Co., 73,619 cubic yards were removed, and under that of the Alabama Dredging and Jetty Company 86,598 cubic yards have been removed up to the 25th of September, 1891. At the beginning of the work under the new project there was a depth of 7 feet through the bar at the mouth of the river, obtained by dredging under the previous project, and a least depth of

9 feet in the river up to Moss Point. Under the new project the work under the first contract was devoted to deepening the cut through the bar at the mouth of the river, and a channel of navigable width and 9½ feet depth obtained. Under the second contracts operations were carried on in the river between Moss Point and the mouth, and a channel of 80 feet wide and 12 feet deep was obtained.

Under the third contract the work has been devoted to deepening the channel through the bar at the mouth of the river to 12 feet.

Work on the river above Moss Point was commenced on December 19, 1891, and suspended January 31, 1892, on account of high water.

The following obstructions were removed during the fiscal year ending June 30, 1892:

Snags pulled and removed	48
Number of cuts made	73
Sunken logs and trees pulled and removed	157
Number of cuts made	285
Overhanging trees felled, and pulled back and cut up	269
Number of cuts made	585

This improvement will not be permanent in its character; $2,500 will be required annually for the removal of snags, etc., in order to maintain the river above Moss Point in its improved condition.

The present indications are that no annual appropriation will be required for preserving the dredged channel, but that $8,000 at intervals of three or four years will be ample.

The extent and present condition of the work is as follows:

Extent.	Condition.
I. Snagging and cutting overhanging trees from head to mouth.	Complete, but needs reworking in preservation of improvement.
II. Dredging channel from Moss Point to mouth of navigable width and 12 feet depth and construction of dam at Lowry Island.	Completed to a width of 80 feet, and in good condition when last examined. Dam completed.
III. Dredging channel of navigable width and 12 feet depth from the mouth to the 12-foot curve in Mississippi Sound length of 18,898 feet.	Completed to a width of 80 feet for a distance of 5,100 feet, and to a width of 120 feet for a distance of 2,450 feet.

The amount estimated for completion is in excess of the original estimate, the reasons for which are that, owing to the extreme hardness of a portion of the bottom to be dredged and the smallness of the appropriations made available, the cost of excavation is in excess of that originally estimated.

Money statement.

July 1, 1891, balance unexpended	$15,833.03
June 30, 1892, amount expended during fiscal year	14,099.87
July 1, 1892, balance unexpended	1,733.16
Amount appropriated by act approved July 13, 1892	20,000.00
Amount available for fiscal year ending June 30, 1893	21,733.16
Amount (estimated) required for completion of existing project	49,000.00
Amount (estimated) required for preservation improvement above Moss Point	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	69,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

	Entries.		Cleared.	
	1892.	1891.	1892.	1891.
Foreign	104,076	58,725	110,887	96,825
Coastwise	31,451	41,658	35,115	42,055
Total	135,527	100,383	146,002	138,880

Comparative statement of shipments to foreign and coastwise ports.

Articles.	1892.		1891.	
	Tons.	Value.	Tons.	Value.
Lumber	183,969	$1,382,963.40	80,413	$888,247.00
Shingles	1,837	9,487.95	....	....
General merchandise	....	241,340.00	....	13,593.00
Total	....	1,633,791.35	....	901,840.00

Q 6.

IMPROVEMENT OF CHICKASAHAY RIVER, MISSISSIPPI.

The act of Congress of August 11, 1888, provided for an examination of the Chickasahay River from its mouth to Enterprise. This examination was made, and report submitted on February 16, 1889.

The approved project is to clear the channel from the mouth up to railroad bridge, near Shubuta, by the removal of logs, snags, and overhanging trees, at an estimated cost of $30,000.

By act of Congress dated September 19, 1890, $5,000 was appropriated for the improvement of the Chickasahay River.

The work performed during the fiscal year ending June 30, 1892, was as follows:

Commenced work at Waynesboro, Miss., October 13, 1891, and suspended December 12, 1891.

The following obstructions were removed:

Overhanging trees felled and cut up	4,500
Number of cuts	5,000
Overhanging trees trimmed	1,500
Logs on bank cut up	6,000

The results obtained by the improvement are as follows:

A high-water channel that allows rafts of much larger size than formerly to be floated down with comparative ease.

The saving to producers by improvement proposed is estimated at about $50,000 annually.

Money statement.

July 1, 1891, balance unexpended	$5,000.00
June 30, 1892, amount expended during fiscal year	4,595.27
July 1, 1892, balance unexpended	404.73
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,404.73
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1892.	
	Tons.	Value.
Lumber	347	$38,197.69

Q 7.

IMPROVEMENT OF BLUFF CREEK, MISSISSIPPI.

An act of Congress of August 11, 1888, directed that an examination of this creek should be made from its mouth to the head of navigation.

The examination was made, and report submitted February 16, 1889.

The project proposed consisted in the removal of snags, logs, and overhanging trees from the mouth up to Vancleaves, at an estimated cost of $1,000.

By act of Congress approved September 19, 1890, $1,000 was appropriated for this work.

Work was commenced in December, 1891, and suspended in February, 1892.

The following work was performed during the fiscal year ending June 30, 1892:

Overhanging trees felled and cut up	500
Overhanging trees felled and pulled back	3,500
Snags cut in the water with saws	49
Snags removed	92
Stumps removed, leveled	341

This stream has been fully improved and the project completed.

The money value of articles transported one way on this creek is estimated at $41,500.

Money statement.

July 1, 1891, balance unexpended	$1,000.00
June 30, 1892, amount expended during fiscal year	999.51
July 1, 1892, balance unexpended	.49

Commercial statistics for fiscal year ending June 30, 1892, Bluff Creek, Mississippi—Vessels engaged.

	1892.	1891.	Tonnage.	
			1892.	1891.
Coastwise	32	29	700	596

Articles shipped up and down stream.

Articles.	1892.		1891.	
	Amount.	Value.	Amount.	Value.
Charcoal ... barrels	374,000	$50,490	310,000	$43,000
Sawlogs ... number	9,000	18,000	5,000	10,000
General merchandise ... tons	1,000	50,000	700	35,000
Total		118,000		88,000

Q 8.

IMPROVEMENT OF LEAF RIVER, MISSISSIPPI.

The act of Congress of August 11, 1888, provided for an examination of Leaf River from its mouth to mouth of Bowie Creek, near the New Orleans and Northeastern Railroad. This examination was made, and report submitted on February 15, 1889.

The approved project is to clear the channel from the mouth of Bowie Creek, for high-water navigation, by the removal of snags, logs, and overhanging trees, at an estimated cost of $25,000.

By act of Congress dated September 19, 1890, $5,000 was appropriated for the improvement of Leaf River.

Work on this improvement was commenced during August, 1891, at Hattiesburg, Miss., and suspended November, 1891. The following work was performed during the fiscal year ending June 30, 1892:

Snags pulled and cut up	1,070
Sunken logs and trees removed	110
Overhanging trees felled and cut up	1,100
Overhanging trees felled and pulled back	1,056
Logs on bank cut up	273
Stumps leveled, blasted, and removed	325

This work has resulted in giving a high-water channel, by removal of logs, snags, etc., from Hattiesburg to Augusta, Miss., a distance of 40 miles.

The present annual commerce to be favorably affected by an improvement is of a value of about $499,600.

Money statement.

July 1, 1891, balance unexpended	$5,000.00
June 30, 1892, amount expended during fiscal year	4,597.86
July 1, 1892, balance unexpended	402.14
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,402.14
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Article.	1892.	
	Tons.	Value.
Lumber	162	$11,836.03

Q 9.

IMPROVEMENT OF HARBOR AT BILOXI BAY, MISSISSIPPI.

The examination of this harbor, provided for by the third section of the river and harbor act of March 3, 1881, was made during the months of August and September, 1881.

The report is contained in Annual Report of Chief of Engineers, 1882, Appendix K 27.

The examination showed that between the roadstead and the Back Bay are situated a series of mud flats, called Deer Island Flats, about 1¼ miles east of Biloxi, having a present depth of 4 feet.

The improvement understood to be desired was to secure through these flats a channel 8 feet deep.

The estimated cost of the work by dredging was $35,000. The act of Congress, August 2, 1882, appropriated $5,000 for the improvement of the roadstead. No project was submitted, the amount appropriated being deemed insufficient for an economical prosecution of the work. Authority was therefore obtained to defer all action until a further appropriation was made. The act of July 5, 1884, directed that the balance of the money heretofore appropriated for the roadsted be applied to the deepening of the channel from Mississippi Sound to the wharves of Biloxi. The desired improvement was the deepening of the channel from Mississippi Sound to the wharves of Biloxi from 4½ feet, the least depth at that time, to 8 feet, and the estimated cost was $55,000. It was not deemed economical or judicious to commence the work with the small amount on hand. Authority was therefore obtained to hold the appropriation until a further one was made to justify a call for bids.

The river and harbor act of August 5, 1886, appropriated $12,500, thus affording, with the balance on hand, the sum of $17,488.55 for carrying on the work of improvenent.

The plans and estimates heretofore submitted were based upon an examination only (not sufficient for laying out the work properly), the limit of time and money preventing a complete survey; therefore a careful survey of the channel from Mississippi Sound to the wharves of Biloxi, to locate channel to be dredged, was recommended to be made.

This recommendation was approved and $900 from the amount available was allotted for the work.

A project and estimates, based on the survey made in April and May, 1887, were submitted July 8, 1887, and approved July 13, 1887.

The sum of $16,523.64 was available July 1, 1887, for the improvement of this harbor.

Advertisement and specifications for dredging were prepared and published, bids were opened August 17, 1887, a contract was entered into with George C. Fobes & Co., of Baltimore, Md., at 17 cents per cubic yard, and dredging operations were commenced September 12, 1887, and completed March 2, 1888. Eighty-four thousand six hundred and eighty-six cubic yards of material were removed.

Bids for improving Biloxi Harbor, Mississippi (dredging), were received and opened November 27, 1888, but as prices (16½ cents per cubic yard) were not satisfactory, all were rejected.

Bids were again solicited and opened January 20, 1890, and contract awarded to Alabama Dredging and Jetty Company at 14¾ cents per cubic yard, measured in the scow. Work commenced July 14, 1890, and continued to November 12, 1890, at which time 97,092 cubic yards had been excavated and the project virtually completed, although a greater width is considered advisable, and it is proposed to expend the appropriation available in that way.

The extent and present condition of the work is as follows:

Extent.	Present condition.
Dredging a channel of 8 feet depth and navigable width through the bar across the west entrance to Biloxi Bay, from Mississippi Sound, a distance of 5,351 feet.	Completed to a depth of 9 feet and width of 120 feet, and when last sounded was in good condition, with not less than 8 feet throughout the dredged channel.

The present project is therefore completed, but the amount on hand can be used to advantage in widening the channel already obtained.

An examination of the dredged channel was made during May, 1892, and it was ascertained that the depth of 8 feet had been maintained; but an accumulation of soft black mud, slightly mixed with very fine sand, was found opposite the first turning point, at the intersection of Reaches 1 and 2 and from the second turning point, the intersection of Reaches 3 and 4, 650 feet south, where the excavation crossed the bar formation on west spit of Deer Island.

During June, 1892, advertisement and specifications for dredging were prepared and published.

Money statement.

July 1, 1891, balance unexpended	$10,851.36
July 1, 1892, balance unexpended	10,851.36

The indications are that not more than $8,000 every four or five years will be ample for the preservation of the improvement. Before the improvement vessels of more than 5 feet draft could not enter the harbor, while since the improvement vessels of 8 feet draft can come to the wharves of Biloxi.

COMMERCIAL STATISTICS.

Articles.		1892.	1891.
Lumber	tons	4,500	3,000
Oysters	do	51,562	34,375
Fish	do	4,482	2,988
Shrimp	do	1,500	1,000
General merchandise	do	110,119	73,413
Total		172,163	114,776

Q 10.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BELOW JACKSON.

The original project for improving this section of the river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep at low water from Jackson down to the mouth by the removal of snags, stumps, roots, logs, and trees, and the clearing of banks of overhanging trees, at an estimated cost of $95,940, based upon the report of a survey made under direction of Capt. C. W. Howell, Corps of Engineers, U. S. Army, during March and April, 1879.

Upon an examination made in December, 1884, it was found that a 5-foot clear channel at low water was not practicable by the method proposed, but that a 2-foot channel at low water could be obtained in that manner, and was all that the present commerce of the river required.

Upon that examination the original estimate was increased $50,000. (See Annual Report, 1885-'86, page 1367.)

In addition to the improvement of the river proper the increased lumber trade of mills situated on the river demands the dredging of the channel over the bar at the mouth of East Pearl River to 12 feet, a rough estimate of the cost of which is $20,000.

The following appropriations have been made:

By act of—	
June 14, 1880	$30,000
March 3, 1881	25,000
August 2, 1882	15,000
July 5, 1884	10,000
August 5, 1886	13,125
By act of—	
August 11, 1888	$15,000
September 19, 1890	20,000
Total	128,125

Under these appropriations work was commenced by contract in December, 1880. Working from Jackson down, 295 miles of river was partially improved.

August 23, 1882, contract work was completed and accepted.

In November, 1882, work on the improvement by hired labor was commenced, and was suspended in November, 1883; resumed in June, 1884; suspended on September 1 on account of high water; resumed December 1, 1884; suspended June 30, 1885, on account of lack of funds; resumed in September, 1885; suspended March 30, 1886, on account of lack of funds; resumed September 5, 1886; suspended November 22, 1887, on account of lack of funds; resumed October 20, 1888; suspended October 23, 1889, on account of lack of funds; resumed in July, 1891, and suspended in May, 1892, on account of high water.

The following is a statement of work performed from 1884 up to June 30, 1891:

Snags removed		7,164
Roots removed		6,808
Sunken logs removed		5,004
Sunken trees removed		2,777
Stumps removed and blasted		2,229
Knees cut and removed		87
Standing trees cut and removed		1,454
Overhanging trees cut and removed		20,141
Standing trees deadened		2,769
Sand and clay removed	cubic yards	11,739¼
Cane removed	running yards	9,422
Piles driven for jetties		256
Willows planted for jetties	cords	666
Willows cut, made into mattresses, and sunk	do	618¼
Trees felled, cut into lengths, and sunk for jetties		1,531
Sunken logs and trees pulled and sunk for jetties		116
Clay dug out, wheeled, transported, and filled in jetties	cubic yards	3,220

The following is a statement of work performed during the fiscal year ending June 30, 1892:

Snags pulled and removed	344
Number of cuts made	113
Sunken logs pulled, cut up, and removed	368
Number of cuts made	133
Sunken trees pulled, cut up, and removed	255
Number of cuts made	174
Stumps cut, blasted, and removed	35
Drift removed, piles	9
Logs on bank cut up and removed	69
Number of cuts made	208
Trees felled, pulled back, and cut up	6,377
Number of cuts made	6,773
Standing trees in channel removed	239
Trees trimmed	68
Number of cuts made	320
Bushes cut	282

Nearly one-half of the amount appropriated has been expended in the removal of the annual accumulation of snags, logs, etc., and in preservation of the improvement.

Fifty-five and one-half miles, from the mouth up, were improved in accordance with the adopted project. Fifty and one-half miles of river, up to Wheats Fields, were improved for a 100-foot wide channel, and 50 miles of river from Wheats Fields to Columbia, Miss., have been partially improved.

From Columbia to Jackson the river had been partially improved by contract. No other work has been done on that section since, and it remains in about the same condition.

The condition of this section of the river on June 30, 1892, is such as to allow light-draft boats to navigate from the mouth at the Rigolets, La., to Wheats Fields, Miss, 106 miles, all the year; from Wheats Fields to Columbia, Miss., 50 miles, on a 6-foot rise, and from Columbia, Miss., to Jackson, Miss., 169 miles, on a 7-foot rise, and then it is dangerous.

The benefits that are derived by the improvements of this section of the river are greater security to navigation between New Orleans, La. and Columbia, Miss., and other towns and settlements situated on the river, and reduced rates of freights and insurance on merchandise and produce.

Large tracts of rich and valuable bottom lands have been reclaimed by the improvement and are now being cultivated.

It is proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1894, to continuing the improvement of the river for a 2-foot channel at low water between Columbia and Jackson.

It is also proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1894, for deepening the channel over the bar at the mouth of East Pearl River and to dredging a channel 12 feet deep at mean low water, so far as the funds will permit.

Owing to caving banks and shifting of the channel the improvements so far made and contemplated are not permanent. An annual expenditure of $5,000 will be required to maintain the river in the condition contemplated by the plan of improvements.

Money statement.

July 1, 1891, balance unexpended	$22,686.20
June 30, 1892, amount expended during fiscal year	10,823.43
July 1, 1892, balance unexpended	11,862.77
Amount appropriated by act approved July 13, 1892	15,000.00
Amount available for fiscal year ending June 30, 1893	26,862.77
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 11.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN CARTHAGE AND JACKSON.

The original condition of this portion of the river was such as to permit navigation only during high water, and even then it was difficult and dangerous.

An examination of this part of the river was made in 1879, and report thereon is contained in the Annual Report of the Chief of Engineers of 1879 (Appendix K 2).

The original project for the improvement of this part of the river consisted in the removal of snags, logs, and overhanging trees, etc., and was to afford a clear channel of navigable width, 5 feet deep, at a low stage of water, from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

An examination made in January, 1887, showed that a clear channel of 5 feet at low water was not practicable by the method on this section of the river, but that a 2-foot channel at low water could be obtained in that manner and was all that the present commerce of the river required.

Upon that examination the original estimate of the cost of the improvement was increased $29,000. (See Annual Report, 1886–'87, Q 2, page 1336.)

The following appropriations have been made:

By act of—	
March 3, 1879	$6,000
June 14, 1880	7,500
March 3, 1881	2,500
August 2, 1882	2,500
August 6, 1886	2,250
By act of—	
August 11, 1888	$2,500
September 19, 1890	3,000
Total	26,250

Under these appropriations work was commenced by contract November 20, 1879. The work, however, not proving satisfactory, the contracts were annulled September 22, 1882, and the work was continued by hired labor during the low-water seasons of 1883 and 1884; suspended in January 1885, on account of lack of funds; resumed January 1, 1887; suspended January 29, 1887, on account of high water; resumed August 1, 1887; suspended November 30, 1887, on account of lack of funds; resumed in September, 1888; suspended December 31, 1888, on account of high water; resumed November 16, 1890; suspended in January, 1891, on account of high water; commenced July 1, 1891, and suspended August 30, 1891, on account of lack of funds.

The following is a statement of work performed up to June 30, 1891:

Snags cut up and removed	30,607
Stumps cut, leveled, and blasted	1,331
Sunken logs cut up and removed	5,148
Sunken trees cut up and removed	793
Overhanging and standing trees felled, pulled back, cut up, and removed	388

The work performed during the fiscal year ending June 30, 1892, was as follows:

Snags cut up and removed	9,703
Stumps cut, leveled, and blasted	627
Logs on bank cut up and removed	1,703
Number of cuts made	2,531
Piles of drift removed	8
Overhanging trees felled, pulled back, and cut up	3,822
Number of cuts made	3,044
Trees trimmed	187
Bushes cut	9,375

About one-half the appropriations have been expended in the removal of the annual accumulation of snags, logs, etc., or in preservation of the improvements.

The entire distance of this part of the river from Carthage to Jackson, 105 miles, has been improved in accordance with the plan of improvements, but owing to caving banks and shifting of the channel will have to be worked over again from time to time.

Nearly one-half of the amount appropriated has been expended in the removal of the annual accumulation of snags, logs, etc., and in preservation of the improvement.

Fifty-five and one-half miles, from the mouth up, were improved in accordance with the adopted project. Fifty and one-half miles of river, up to Wheats Fields, were improved for a 100-foot wide channel, and 50 miles of river from Wheats Fields to Columbia, Miss., have been partially improved.

From Columbia to Jackson the river had been partially improved by contract. No other work has been done on that section since, and it remains in about the same condition.

The condition of this section of the river on June 30, 1892, is such as to allow light-draft boats to navigate from the mouth at the Rigolets, La., to Wheats Fields, Miss, 106 miles, all the year; from Wheats Fields to Columbia, Miss., 50 miles, on a 6-foot rise, and from Columbia, Miss., to Jackson, Miss., 169 miles, on a 7-foot rise, and then it is dangerous.

The benefits that are derived by the improvements of this section of the river are greater security to navigation between New Orleans, La. and Columbia, Miss., and other towns and settlements situated on the river, and reduced rates of freights and insurance on merchandise and produce.

Large tracts of rich and valuable bottom lands have been reclaimed by the improvement and are now being cultivated.

It is proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1894, to continuing the improvement of the river for a 2-foot channel at low water between Columbia and Jackson.

It is also proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1894, for deepening the channel over the bar at the mouth of East Pearl River and to dredging a channel 12 feet deep at mean low water, so far as the funds will permit.

Owing to caving banks and shifting of the channel the improvements so far made and contemplated are not permanent. An annual expenditure of $5,000 will be required to maintain the river in the condition contemplated by the plan of improvements.

Money statement.

July 1, 1891, balance unexpended	$22,686.20
June 30, 1892, amount expended during fiscal year	10,823.43
July 1, 1892, balance unexpended	11,862.77
Amount appropriated by act approved July 13, 1892	15,000.00
Amount available for fiscal year ending June 30, 1893	26,862.77
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 11.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN CARTHAGE AND JACKSON.

The original condition of this portion of the river was such as to permit navigation only during high water, and even then it was difficult and dangerous.

An examination of this part of the river was made in 1879, and report thereon is contained in the Annual Report of the Chief of Engineers of 1879 (Appendix K 2).

The original project for the improvement of this part of the river consisted in the removal of snags, logs, and overhanging trees, etc., and was to afford a clear channel of navigable width, 5 feet deep, at a low stage of water, from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

An examination made in January, 1887, showed that a clear channel of 5 feet at low water was not practicable by the method on this section of the river, but that a 2-foot channel at low water could be obtained in that manner and was all that the present commerce of the river required.

Upon that examination the original estimate of the cost of the improvement was increased $29,000. (See Annual Report, 1886–'87, Q 2, page 1336.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$6,000	August 11, 1888	$2,500
June 14, 1880	7,500	September 19, 1890	3,000
March 3, 1881	2,500		
August 2, 1882	2,500	Total	26,250
August 6, 1886	2,250		

Under these appropriations work was commenced by contract November 20, 1879. The work, however, not proving satisfactory, the contracts were annulled September 22, 1882, and the work was continued by hired labor during the low-water seasons of 1883 and 1884; suspended in January 1885, on account of lack of funds; resumed January 1, 1887; suspended January 29, 1887, on account of high water; resumed August 1, 1887; suspended November 30, 1887, on account of lack of funds; resumed in September, 1888; suspended December 31, 1888, on account of high water; resumed November 16, 1890; suspended in January, 1891, on account of high water; commenced July 1, 1891, and suspended August 30, 1891, on account of lack of funds.

The following is a statement of work performed up to June 30, 1891:

Snags cut up and removed	30,607
Stumps cut, leveled, and blasted	1,331
Sunken logs cut up and removed	5,148
Sunken trees cut up and removed	793
Overhanging and standing trees felled, pulled back, cut up, and removed	388

The work performed during the fiscal year ending June 30, 1892, was as follows:

Snags cut up and removed	9,703
Stumps cut, leveled, and blasted	627
Logs on bank cut up and removed	1,703
Number of cuts made	2,531
Piles of drift removed	8
Overhanging trees felled, pulled back, and cut up	3,822
Number of cuts made	3,044
Trees trimmed	187
Bushes cut	9,375

About one-half the appropriations have been expended in the removal of the annual accumulation of snags, logs, etc., or in preservation of the improvements.

The entire distance of this part of the river from Carthage to Jackson, 105 miles, has been improved in accordance with the plan of improvements, but owing to caving banks and shifting of the channel will have to be worked over again from time to time.

An annual expenditure of $2,400 will be required to maintain the river in the condition contemplated by the plan of improvement.

The condition of the river on June 30, 1892, is such as to allow light-draft boats to navigate safely on a 3-foot rise above ordinary low water from Carthage down to Jackson.

The reduction and saving in railroad freights, as well as the reduced rates of insurance on freights, both up and down stream, due to river competition, are considerable.

It is proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1894, to remove the annual accumulation of logs, snags, trees, etc., and in preservation of the improvements.

Money statement.

July 1, 1891, balance unexpended	$1,470.90
June 30, 1892, amount expended during fiscal year	1,288.28
July 1, 1892, balance unexpended	182.62
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,182.62
Amount (estimated) required for preservation of improvement	2,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	2,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Vessels engaged on Pearl River, Mississippi.

No.	Kind.	Length	Draft.	Tonnage.
		Feet.	*Feet.*	*Tons.*
1	Stern-wheel steamboat	110	3	90
1	Propeller	40	3	15
6	Flat boats	50	1½	250

Carried upstream.

Articles.	Tons.	Value.
General merchandise	900	$45,000
Grain	400	8,000
Fertilizer	500	10,000
Machinery	100	8,000
Total	1,900	71,000

Carried downstream.

Articles.	Tons.	Approximate value.
Cotton	700	$120,000
Staves	230	3,000
Lumber	300	7,200
Shingles	50	1,000
Firewood	2,000	7,500
Saw logs	2,000	36,000
Produce, fowls, etc	30	1,500
Total	5,310	176,200

Q 12.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN EDINBURG AND CARTHAGE.

A survey of this part of Pearl River was made during the month of November, 1883, and report thereon is contained in the Annual Report of the Chief of Engineers of 1884. (Appendix Q 18.)

The original project for the improvement of this river was to afford a high-water channel from Edinburg to Carthage, a distance of 24¾ miles, for six or eight months of the year, at a estimated cost of $13,464.

The following appropriations have been made:

By act of—	
July 5, 1884	$2,500
August 5, 1886	2,250
August 11, 1888	5,000
September 19, 1890	5,000
Total	14,750

Under these appropriations work was commenced November 17, 1884; suspended January 23, 1885, on account of high water; resumed September 3, 1885; suspended September 30, 1885, on account of lack of funds; resumed November 16, 1886; suspended December 18, 1886, on account of high water; resumed December 1, 1887; suspended December 27, 1887, on account of high water; resumed June 1, 1889; suspended December 12, 1889, on account of high water; resumed in September, 1891, and suspended January, 1892, on account of high water.

The following is a statement of work up to June 30, 1890:

Snags, stumps, sunken logs, and trees cut up and removed	121,855
Trees standing in channel removed	368
Fallen trees removed	94
Overhanging trees cut and removed	10,467
Banks cleared of brush ....yards..	6,491

No work was done during the fiscal year ending June 30, 1891.

The entire distance of this part of the river, from Edinburg to Carthage, 24¾ miles, has been fully improved and the project completed.

The following is a statement of work during the fiscal year ending June 30, 1892:

Snags cut up and removed	20,695
Stumps cut, leveled, and blasted	2,189
Piles of drift removed	31
Logs on banks cut up	4,090
Number of cuts made	5,883
Bushes cut	21,735
Trees trimmed	638
Overhanging trees felled, pulled back, and cut up	5,637
Number of cuts made	4,528

The condition of this portion of the river on June 30, 1891, was such as to allow light-draft boats to navigate with comparative safety from Edinburg to Carthage on a 4½-foot rise above ordinary low water.

The condition of this section of the river on June 30, 1892, was such as to allow light-draft boats to navigate safely from Edinburg to Carthage on a 4-foot rise above low water.

About one-half of the last appropriation has been expended in the removal of the annual accumulation of snags, logs, and trees, and in the preservation of the improvement.

Owing to caving banks and shifting of the channel the improvements

made are not permanent. It is estimated that an annual expenditure of $500 will be required to maintain the river in the condition contemplated by the plan of improvement.

The reduction in freights and insurance, due to river competition, are considerable.

Commercial statistics.—One stern-wheel steamboat, 120 feet long, 3 feet draft of water, 110 tons burden, has been employed during the last fiscal year; 1,000 tons general merchandise, grain, fertilizers, furniture, and machinery were carried upstream; 450 tons cotton and country produce were carried downstream.

Money statement.

July 1, 1891, balance unexpended	$5,028.87
June 30, 1892, amount expended during fiscal year	2,654.57
July 1, 1892, balance unexpended	2,374.30
Amount appropriated by act approved July 13, 1892	500.00
Amount available for fiscal year ending June 30, 1893	2,874.30
Amount (estimated) required for preservation of improvement	500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 13.

IMPROVEMENT OF BOGUE CHITTO, LOUISIANA.

An act of Congress of August 11, 1888, directed an examination of this river to be made.

The examination was made and report submitted June 24, 1889.

The project proposed consisted in closing the west mouth and the removal of snags, logs, and overhanging trees, and fish traps from the other mouth and up to Alfords Bridge, so that the river could be used by small river steamers of 3 feet draft the greater part of the year. The estimated cost was $55,000. Five thousand dollars was appropriated by act of Congress approved September 19, 1890, to be expended from its mouth to where the first bridge obstructing navigation is located. The only work done to the close of the fiscal year ending June 30, 1892, is preparation of plant.

The annual saving in freight to the present commerce that would be effected by the improvement of the river is estimated at about $30,000.

Money statement.

July 1, 1891, balance unexpended	$5,000.00
June 30, 1892, amount expended during fiscal year	1,000.00
July 1, 1892, balance unexpended	4,000.00
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	9,000.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles shipped downstream for fiscal year ending June 30, 1892, Bogue Chitto, Louisiana.

Articles.	1892.		1891.	
	Amount.	Value.	Amount.	Value.
Saw logs .... number..	17,000	$34,000	10,000	$20,000
Hewn timber .... cubic feet..	88,000	13,200	50,000	6,500
Total	....	47,200	....	26,500

APPENDIX R.

INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 1, 1892.

GENERAL: I have the honor to submit my annual report upon the improvement of South Pass of the Mississippi River for the fiscal year ending June 30, 1892.

But little construction work was done at the Head of the Passes and in South Pass itself during the year. A portion of upper dam was rebuilt, but later on it, with older portions, washed out.

At the mouth of South Pass 8 new wing dams were built, and 20 of the older ones repaired and some of them extended. Six cribs were added to the east jetty over a distance of 281 feet.

The channel, as required by law, was maintained at the head of South Pass and "through the pass itself," during the year, but during a period of thirty-two days from May 20 to June 20, both dates inclusive, there was not a channel "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width through the jetties," at the mouth of South Pass. During this period, however, there was a navigable depth of 28.1 feet.

Over an area containing 1¼ square miles lying immediately in front of the sea ends of the jetties there was an average shoaling of 1.59 feet during the year.

I transmit herewith the report of Mr. C. Donovan, assistant engineer, which, together with the charts to accompany the same, gives all details of the construction work done during the year, the present condition of the works, and the results they have produced, not only during the year but since 1875.

Estimate of funds required for examinations and surveys at South Pass, Mississipi River, during the fiscal year ending June 30, 1894.

1 assistant engineer	$2,700
1 recorder	1,380
1 steam engineer	1,200
1 water-level observer	120
6 seamen	3,370
Rent of office	180
Rent of quarters for assistant engineers	240
Mileage and traveling expenses	200
Repairs to launch and boats	700
Supplies for launch and office	300
Contingencies	2,000
Total	12,390

Money statement.

July 1, 1891, balance unexpended	$10,000.00
June 30, 1892, amount expended during fiscal year	9,200.90
July 1, 1892, balance unexpended	799.10
Amount appropriated by act of August 11, 1888	10,000.00
Amount available for fiscal year ending June 30, 1893	10,799.10
Amount that can be profitably expended in fiscal year ending June 30, 1894 / Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,890.00

Statement of expenditures on account of appropriation for "examinations and surveys at South Pass, Mississippi River," for the fiscal year ending June 30, 1892, made in compliance with section 4 of river and harbor act of August 11, 1888.

Amount appropriated by act of August 11, 1888 .... $10,000.00

EXPENDITURES.

1 assistant engineer, 12 months, at $200	2,400.00
1 recorder, 12 months, at $100	1,200.00
1 engineer launch, 12 months, at $100	1,200.00
1 first-class seaman, 12 months, at $70	840.00
2 first-class seamen, 24 months, at $65	1,560.00
1 first-class seaman, 12 months, at $60	720.00
1 first-class seaman, 5 days, at $2	10.00
1 second-class seaman, 20 days, at 1.75	35.00
1 water-level observer, 12 months, at $10	120.00
1 clerk, 1 month, at $100	100.00
Rent of office and quarters at Port Eads, La., 12 months, at $35	420.00
Rent of office U. S. engineer at New Orleans, La., 1 month, at $45	45.00
	8,650.00
Traveling expenses, assistant engineer	45.05
Stationery	73.25
Repairs to steam launch *General Reese*	173.13
Ship chandlery, hardware, etc	240.27
Miscellaneous expenditures	19.20
Total expenditures	9,200.90

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Port Eads, La., July 1, 1892.

SIR: I have the honor to report upon the improvement of South Pass of the Mississippi River during the fiscal year ending June 30, 1892, relative to the amount and character of the work done during the year, the present condition of the works, and the results of examinations and surveys made in connection therewith.

This work is, and has been since March, 1876, carried on under the direction of Messrs. James F. How and Estill McHenry, of St. Louis, Mo., by authority granted them as the legal representatives of James B. Eads, deceased, in an act of Congress approved March 3, 1875.

The following charts accompanying this report:

No. 1. Chart of the channel from South Pass Light-house, through the jetties, to deep water in the Gulf.

No. 2. Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.

No. 3. Chart of a part of South Pass, from South Pass Light-house to Grand Bayou.

No. 4. Chart of a part of South Pass, from Grand Bayou to the Head of the Passes.

No. 5. Chart of the Head of the Passes.

No. 6. Plan and comparative profiles of South Pass.

No. 7. Diagrams showing changes in the Gulf for each year from 1876 to 1892.

AT THE HEAD OF THE PASSES.

Upper dam.—During the year, and previous to January 1, about 30 feet of the east end of this dam was undermined and carried away. In January 47 feet of new work was added to the east end, but it did not withstand the force of the rising river, and, with some of the older portion, was carried away during the month of May, as was also 53 feet in length of the west end.

As originally constructed in the spring of 1879, this dam was 1,675 feet in length above water, with a foundation length of 1,880 feet. (See Annual Report for 1879 and chart therewith.) But 512 feet in length of this dam is now in place, and while well backed by the land formation below it, still the scour at the east end continues, and until checked the dam will be in danger of being completely washed out.

The following materials were used in this dam: Seven hundred and ninety-six cords of willows, 24 piles, 369 linear feet of 12 by 12 inch timber, 41 screw bolts, and 10 driftbolts.

West T-head.—To this structure 88 cords of willows were added during the year, and it is in good condition.

For the location of these works, and all others at the Head of the Passes, see chart No. 5.

Mattress sills across Southwest Pass and Pass à Loutre.—These sills remain in place, and have undergone no change during the year.

IN SOUTH PASS.

To Wing Dam No. 2 in Goat Island Reach, 81 cords of willows were added. No other work was done in the pass nor was it required.

The wing dams in Goat Island and Grand Bayou reaches are shown on charts 3 and 4. As to their condition, it may be said that they are generally temporary structures which induce a gradual building out of the shore to such an extent that after a time they are not required and are allowed to deteriorate.

AT THE MOUTH OF SOUTH PASS.

East jetty.—The work done on this jetty during the year consisted in continuing the crib-work capping from a point 4,326 feet below East Point to a point 4,045 feet below the same, a distance of 281 feet.

Over this distance six cribs were placed and filled with stone. Five of them were each 56 feet long, 9 feet wide, and from 3 to 4½ feet high, and the other one was of the same dimensions except its length, which was 40 feet. The last three cribs were placed as shown on Chart No. 1, with the idea that they might aid to some degree in preventing further recession of the land formation to the eastward of this jetty, which at the time joined the jetty at the point where the cribs were placed, but for this purpose they were not effective.

The concrete wall on this jetty remained in fair condition during the year, its average subsidence being eight one-hundredths of a foot.

This wall was completed in September, 1889, since which time the average subsidence has been twenty-eight one-hundredths of a foot.

In the maintenance of this jetty the following materials were used during the year: 8,750 linear feet of 12 by 12 inch timber, 9,764 feet B. M. of 2 and 3 by 12 inch plank, 1,156 driftbolts, 92 screw bolts, and 617 cubic yards of stone.

West jetty.—This jetty is completely buried; the concrete wall is entirely out of sight, covered by sand and mud in which the marsh grass is growing.

The extreme outer end is 3 feet below the surface of the water, and has 1½ feet of sand over it. A glance at Chart No. 1 will show that this jetty is secure for all time and will consequently require no further work upon it.

Inner east jetty.—Additional materials, consisting of 6,753 cords of willows, 1,465 cubic yards of stone, and 602 piles, were added to this jetty during the year, at different localities. The work is in good condition.

Inner west jetty.—This work received an addition of 293 cords of willows, 75 cubic yards of stone, and 99 piles, and is also in good condition.

WING DAMS.

Eight new wing dams were built during the year, many of the old ones repaired, and some of them extended. The construction is similar to that which has been followed for several years, and consists of parallel rows of piles, generally two, but sometimes three, between which willows loaded with stone or earth are placed. The piles in each row are connected by a 12 by 12 inch timber bolted to them about 7 feet above the water, and to these are bolted horizontal ties of the same timber which prevent the piles spreading when willows are forced between them.

More attention has been given to the lengths of these dams than heretofore, with a view to giving a uniform width between opposite dams, and where possible to keep the ends of the dams on a straight line.

The following table gives the materials used in the construction and repair of wing dams during the year, and on Chart No. 1 the location of each is given.

Numbers.		Length.	Width.	Piles.	Willows.	Stone.	Linear feet 12x12 in. timber.	Bolts.	
Old.	New.							Screw.	Drift.
		Feet.	*Feet.*	*No.*	*Cords.*	*Cu. yds.*			
1	....	30	7½	....	22	....	....	....	....
3	....	29	7½	7	18	....	76	11	....
8	....	35	15	15	161	47	106	19	....
9	....	50	13	24	148	34	148	21	1
10	....	58	17	2	....	....	21	4	....
12	....	28	8	7	....	....	....	....	....
13	....	47	9½	8	....	....	....	....	....
15	....	37	9	13	5	8	101	15	1
16	....	35	9½	10	93	27	98	16	....
17	....	40	9	13	93	18	105	20	1
18	....	....	....	....	21	....	....	....	....
20	....	41	7	11	18	....	80	13	....
21	....	55	8½	....	24	....	....	....	....
24	....	52	8	....	24	....	....	....	....
30	....	147	17	3	....	....	....	....	....
31	....	135	14	17	87	....	163	26	....
32	....	127	13	13	56	....	138	26	....
35	....	108	15	15	263	26	211	36	2
36	....	60	14	12	226	26	155	24	4
37	....	115	16	12	147	47	181	29	....
....	38	75	10	20	146	30	146	26	....
....	39	74	10	27	166	51	231	40	....
....	40	95	10	31	190	48	237	34	10
....	41	34	10	15	108	26	100	16	4
....	42	29	7	10	44	....	....	....	....
....	43	17	8	6	25	....	....	....	....
....	44	13	8	6	10	....	....	....	....
....	45	32	10	11	65	21	87	19	....
....	....	....	....	308	2,160	409	2,384	395	23

DREDGING.

More or less dredging was required each month during the year in order to maintain the required channel, most of the work being done during the months of August, September, November, January, March, and June. The time during which dredging was done amounted to seventy-seven days of ten hours each.

THE FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, and laborers, was 45 in number.

EXAMINATIONS AND SURVEYS.

The results of examinations and surveys made during the year were reported monthly, and essential parts of the same are contained herein, together with the results of more extended and recent surveys.

To give descriptively and in detail the results deduced from the many surveys and examinations made during the year would make a voluminous though uninteresting report. All this information is given in concise form on charts, diagrams, and in tables herein, and will be found to contain interesting details not only for the year but since 1875.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5. The area covered by the survey was mostly sounded during the month of December, while the river was low. A survey during that stage of the river gives more nearly a normal condition of the channel than one made as heretofore during a rising or high stage, at which time the channel is constantly changing. Again, during the high stage of the river there are in places strong eddies and whirls in which it is almost impossible to control a boat so as to get accurate soundings.

This survey is not equitably comparable with earlier ones made during a high stage of the river, though if a comparison be made we would find unimportant changes except in Pass à Loutre.

By reference to Chart No. 5 on which there is a sketch showing the relative location of the Pass à Loutre crevasse to this area one will readily understand the influence of this crevasse in diverting the water from the other passes, and fully recognize in the wide and deep channel leading into Pass à Loutre the effect the crevasse is having in this pass.

This channel is still increasing, the upper dam is being rapidly undermined and carried away, and in turn the rapid current encroaches upon the land formation below, and it is wearing away rapidly.

Another attempt will be made to close Pass à Loutre crevasse during the next low-water season, though in the meantime, if the remaining 512 feet of upper dam should be carried away. the effect upon South Pass may be serious.

The changes in the channel from the main river into South Pass during the year, and since 1875, are shown on Chart No. 6.

During the year the depth from the main river into South Pass has not been less than 29 feet, and at all times there has been a very wide 26-foot channel. The present depth is 34.4 feet, the 26-foot channel is 880 feet wide, and the 30-foot channel 620 feet wide.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

During the month of October, 1891, I made a complete survey of South Pass, the charts of which are Nos. 3 and 4. By reference to the profiles on Chart No. 6 it will be seen that as a general result the pass shoaled during the year. These profiles afford the most minute details with reference to the shoaling during the year and since 1875.

The required channel having "a navigable depth of 26 feet" was maintained during the year. The shoalest water found at any time was during the month of March, and in a reach from 1 to 1¼ miles above South Pass Light-House. There the depth was 26.2 feet, and the 26-foot channel was 210 feet wide.

Goat Island Reach is at the present time the shoalest, having a depth of 27 feet, and a width of 210 feet for the 26-foot channel.

Charts 3 and 4 represent about the normal channel of the pass during the year, and the following tables compiled therefrom give the depth and width of the same.

Tabulated statement of the depth and width of channel throughout South Pass of the Mississippi River, from East Point to 30-foot depth in the main river, given in separate reaches one-fourth of a mile in length, from a survey made in October, 1891.

Locality.		Least depth.	Least width for—	
From—	To above East Point.		26-foot depth.	30-foot depth.
East Point	¼ mile	26.6	140	(*a*)
Above East Point:				
¼ mile	½ mile	28.4	240	(*b*)
½ mile	¾ mile	30.0	280	100
¾ mile	1 mile	33.7	260	140
First mile		26.6	140	......
1 mile	1¼ miles	29.5	250	(*c*)
1¼ miles	1½ miles	27.8	280	(*d*)
1½ miles	1¾ miles	27.6	330	(*e*)
1¾ miles	2 miles	30.5	370	40
Second mile		27.6	250	......
Above East Point—Continued.				
2 miles	2¼ miles	31.0	410	210
2¼ miles	2½ miles	32.0	390	200
2½ miles	2¾ miles	31.5	430	190
2¾ miles	3 miles	29.5	430	(*f*)
Third mile		29.5	390	......
3 miles	3¼ miles	30.5	330	60
3¼ miles	3½ miles	28.8	200	(*g*)
3½ miles	3¾ miles	27.8	200	(*h*)
3¾ miles	4 miles	30.2	260	80
Fourth mile		27.8	200	......

Tabulated statement of the depth and width of channel, etc.—Continued.

Locality. From—	Locality. To above East Point.	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.	Locality. From—	Locality. To above East Point.	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.
Above East Point—Continued.					Above East Point—Continued.				
4 miles	4¼ miles.	32.5	320	170	8 miles	8¼ miles.	34.5	350	260
4¼ miles	4½ miles.	29.3	370	(i)	8¼ miles	8½ miles.	34.5	340	240
4½ miles	4¾ miles.	31.0	420	150	8½ miles	8¾ miles.	34.5	280	200
4¾ miles	5 miles.	33.0	270	150	8¾ miles	9 miles.	35.0	260	190
Fifth mile		29.3	270	......	Ninth mile		34.5	260	190
5 miles	5¼ miles.	30.0	260	40	9 miles	9¼ miles.	34.0	250	150
5¼ miles	5½ miles.	27.5	370	(k)	9¼ miles	9½ miles.	29.2	340	(r)
5½ miles	5¾ miles.	27.5	320	(m)	9½ miles	9¾ miles.	32.3	360	270
5¾ miles	6 miles.	27.5	330	(n)	9¾ miles	10 miles.	51.0	300	270
Sixth mile		27.5	260	......	Tenth mile		29.2	250	......
6 miles	6¼ miles.	27.7	460	(o)	10 miles	10¼ miles	35.0	300	270
6¼ miles	6½ miles.	28.0	290	(p)	10¼ miles	10½ miles	37.0	320	250
6½ miles	6¾ miles.	30.3	400	220	10½ miles	10¾ miles	39.0	330	230
6¾ miles	7 miles.	33.0	400	310	10¾ miles	11 miles.	35.0	310	300
Seventh mile		27.7	290	......	Eleventh mile		35.0	300	230
7 miles	7¼ miles.	30.6	440	80	11 miles	11¼ miles	43.0	(*)	400
7¼ miles	7½ miles.	30.7	400	110	11¼ miles	11½ miles	29.0	(*)	(s)
7½ miles	7¾ miles.	34.0	360	270	11½ miles	11¾ miles	29.0	(*)	(t)
7¾ miles	8 miles.	39.0	340	270	11¾ miles	12 miles.	†33.0	(†)	(†)
Eighth mile		30.6	340	80	Twelfth mile		29.0	(*)	......

*Very wide. †In Mississippi River, above the Head of the Passes.

Length of the portion of this reach lacking a central depth of 30 feet.

	Feet.		Feet.
(a)	1,320	(m)	1,220
(b)	1,320	(n)	1,100
(c)	430	(o)	1,320
(d)	1,320	(p)	1,320
(e)	1,010	(r)	500
(f)	190	(s)	370
(g)	620	(t)	270
(h)	1,320		
(i)	400	Total	15,350
(k)	1,320		

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties and beyond them to deep water in the gulf is shown on chart No. 1.

The required channel "26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width," was maintained by the aid of dredging, except for thirty-two days from May 20 to June 20, both dates inclusive.

On May 20 the 26-foot channel was found to be but 160 feet wide for a distance of 190 feet from the head of the east jetty, and on the same day there was not "a central depth of 30 feet without regard to width" through a reach 1,260 feet in length from 840 to 2,100 feet below East Point. The central depth in the reach was 28.1 feet.

At the time this shoaling took place the dredge-boat was undergoing necessary repairs. She returned here May 29 and commenced work on the following morning. Many days dredging were done without permanently increasing the depth of the channel, though many thousand cubic yards of fine, clear, and compact sand were being removed. About June 17 the current seemed to be acting with more effect, the channel improved more rapidly, except in spots, which yielded slowly to the combined forces of the current and dredging, but on the morning of June 21 the required depth and width of channel again obtained.

The variations in the depth of the jetty channel during the year may be known rom the profiles on chart No. 6 and from the following tables:

Tabulated statement regarding the minimum depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made monthly during the fiscal year ending June 30, 1892.

Date.	Distance from East Point, in feet.								
	0–2,000.			2,000–4,000.			4,000–6,000.		
	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.
1891.									
June	33.0	350	150	31.1	360	220	32.0	300	150
July	31.4	300	70	30.4	310	80	30.4	270	130
August	31.0	240	80	31.0	340	90	31.0	260	70
September	30.6	230	40	30.6	300	60	30.7	240	70
October	31.0	230	30	30.8	285	30	30.8	235	25
November	31.2	210	30	31.0	280	60	31.3	245	60
December	30.1	220	20	30.3	260	30	30.6	250	70
1892.									
January	31.3	210	30	31.6	265	40	31.3	230	40
February	30.5	270	30	30.8	270	40	30.8	250	65
March	30.8	255	40	30.7	280	50	31.4	240	70
April	32.0	210	60	32.0	305	115	33.7	260	150
May	*28.1	†160	....	*29.6	340	....	38.0	295	230
June	*30.4	†205	40	32.3	340	125	36.0	310	240

Date.	Distance from East Point, in feet.								
	6,000–8,000.			8,000–10,000.			10,000–12,000.		
	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth	Least depth.	Least width for— 26-foot depth.	Least width for— 30-foot depth.
1891.									
June	34.7	260	200	37.0	270	200	35.0	270	200
July	33.3	220	190	35.8	250	170	34.8	240	170
August	32.3	220	170	32.9	240	140	31.4	215	115
September	31.0	240	130	31.5	230	120	....	....	....
October	31.2	215	80	31.2	225	110	30.7	240	70
November	31.2	220	85	31.1	230	90	30.6	230	50
December	31.4	210	100	31.3	220	90	32.0	235	80
1892.									
January	31.3	220	70	31.8	220	80	32.2	235	60
February	31.0	235	90	31.1	205	80	31.7	200	65
March	31.7	220	100	31.2	215	70	31.0	240	50
April	32.0	210	150	30.5	210	55	30.6	210	50
May	35.0	260	180	33.0	260	175	32.0	255	110
June	37.0	270	215	36.6	280	210	33.2	280	220

* Central depth less than 30 feet from May 20 to June 20, both dates inclusive, and varied from 28.1 to 29.6 feet.
† Twenty-six-foot channel 160 feet wide from May 20 to June 20, both dates inclusive.

During the month of July, 1891, the channel beyond the ends of the jetties, and on a direct course from there to the sea, had a central depth of 26.4 feet, and the 26-foot channel was 130 feet wide. During the month of August this channel was dredged, and since that time has maintained a depth of about 32.5 feet, the 26-foot channel varying in width from 110 to 630 feet, and the 30-foot channel from 40 to 100 feet.

The present depth of this channel is 31.6 feet, the 26-foot channel being 500 and the 30-foot channel 80 feet in width.

The channel turning to the eastward beyond the end of the east jetty maintained the required depth and width throughout the year.

The following table gives the depths through the jetties from 1875 to the present time:

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875—June	22.5	18.7	16.7	10.2	-9.7	9.2
1876—May	23.3	20.3	22.0	21.0	17.1	15.0
August	23.5	19.6	21.0	23.5	23.0	19.8
November	22.0	20.3	21.1	21.2	21.1	20.3
1877—March	24.1	21.1	23.2	22.0	21.2	20.5
July	24.9	24.0	26.0	23.8	23.5	20.3
October 25 to December 14	26.3	24.4	28.5	24.2	23.0	23.7
1878—March	26.0	25.9	35.5	25.4	24.3	23.0
December	28.4	26.4	35.7	27.1	25.3	23.0
1879—March	28.6	27.5	43.4	27.0	27.0	27.0
June	27.5	28.4	47.7	29.2	29.2	28.0
July	30.5	30.7	....	31.0	30.7	30.5
December	31.0	31.0	48.3	31.7	31.8	30.8
1880—June	31.0	32.5	47.8	31.4	35.1	32.0
July	30.5	31.0	44.0	30.8	31.5	30.5
August	30.5	30.4	46.0	32.0	32.0	30.0
September	30.7	31.0	44.4	30.6	32.0	31.5
October	31.0	31.5	41.0	30.3	31.0	30.5
November	30.6	31.0	40.3	30.8	30.9	30.3
December	30.9	30.6	43.0	30.8	31.0	30.3
1881—January	30.5	30.4	41.9	33.2	30.7	30.3
February	30.4	30.2	41.6	32.0	31.0	30.0
March	31.5	31.2	41.3	32.0	32.0	30.5
April	30.4	30.0	43.0	33.0	33.0	30.5
May	30.2	30.5	42.7	32.6	30.5	31.2
June	30.0	30.5	43.8	32.0	31.7	31.7
July	31.0	32.0	42.5	33.5	33.0	32.0
August	30.1	32.0	37.6	32.0	31.0	30.2
October	30.2	30.3	38.3	31.4	31.2	30.3
November	30.8	31.8	39.2	30.4	30.0	30.1
December	30.2	32.8	39.4	30.8	30.2	30.0
1882—January	30.5	30.4	41.3	31.1	30.2	30.7
February	31.8	36.0	39.7	30.5	30.8	30.2
March	31.2	30.6	39.2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33.0
May	30.5	32.5	39.4	31.0	31.3	31.0
June	30.8	35.5	39.0	31.2	31.3	31.0
July	30.0	32.7	38.7	30.6	31.3	31.5
August	30.3	32.2	38.1	31.8	31.8	30.5
September	30.1	31.5	38.3	31.9	30.8	30.5
October	30.0	31.0	37.1	31.0	31.4	31.2
November	30.0	32.0	38.1	21.5	31.2	31.2
December	31.0	31.0	37.0	31.2	31.0	30.4
1883—January	31.0	31.0	35.2	30.2	30.1	30.1
February	31.2	31.2	36.0	30.5	30.0	30.1
March	32.3	32.6	45.7	31.5	30.3	30.3
April	33.7	35.0	44.0	32.2	30.0	39.0
May	33.2	36.3	46.0	32.3	30.3	32.4
June	32.5	34.2	45.0	33.4	31.0	33.0
July	33.8	34.9	44.0	32.0	31.5	31.8
August	32.1	38.2	48.0	33.4	33.4	32.2
September	33.4	34.3	46.0	32.3	32.3	30.6
October	32.7	34.1	41.5	32.0	32.0	30.5
November	31.0	33.8	43.8	34.5	31.5	31.0
December	30.5	32.6	43.0	31.6	31.6	30.2
1884—January	31.2	32.2	39.2	32.7	31.8	30.3
February	32.0	31.5	41.3	31.6	31.0	30.7
March	35.7	39.5	41.6	34.0	33.8	38.7
April	35.3	37.3	41.5	31.7	32.7	35.4
May	34.9	35.8	42.3	34.3	35.1	33.0
June	35.0	35.8	41.1	34.0	35.0	35.0
August	31.9	35.8	41.9	33.9	35.0	32.0
September	32.0	34.0	39.0	33.1	33.7	33.5
October	31.1	33.4	38.6	32.6	32.6	32.5
November	32.8	32.8	37.2	32.2	32.4	30.8
December	31.6	32.6	37.1	31.1	31.5	31.4
1885—January	36.7	36.4	36.9	33.1	34.6	32.8
February	41.7	36.3	35.7	30.5	34.1	36.2
March	35.5	36.0	36.1	31.0	31.7	35.7
April	36.0	35.5	37.0	32.0	32.6	32.0
May	36.7	35.0	35.6	31.5	33.5	31.5
June	34.7	33.7	35.7	32.8	32.8	31.3
July	36.3	33.1	36.5	33.7	33.6	31.0
August	36.5	35.6	37.6	33.0	32.6	31.0
September	35.3	33.3	35.2	32.2	30.7	31.7
October	33.8	33.7	35.8	31.3	30.4	30.4
November	32.7	32.8	35.1	30.8	30.6	30.1
December	33.0	32.2	34.2	30.9	30.5	30.6
1886—January	33.6	32.5	33.0	30.2	30.2	28.0
February	32.8	32.8	34.1	31.3	30.9	30.0
March	32.8	35.8	34.0	35.0	33.1	32.0

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1886—April	35.4	34.5	34.5	33.7	33.7	31.0
May	35.9	35.6	34.2	31.0	36.0	34.4
June	38.2	35.2	33.4	33.2	34.5	36.5
July	36.7	36.7	36.2	32.8	32.7	37.0
August	35.0	36.3	35.7	34.8	33.8	34.7
September	34.5	35.6	34.6	33.7	33.6	33.0
October	35.0	36.2	34.4	33.0	34.1	33.0
November	34.5	35.6	34.8	32.9	33.0	33.5
December	34.0	35.0	35.3	33.6	32.6	33.0
1887—January	33.6	34.0	33.3	32.3	32.7	33.4
February	36.4	34.4	35.4	31.3	34.1	32.4
March	35.5	35.5	32.6	35.5	35.5	33.8
April	38.8	37.0	33.7	31.0	34.8	35.5
May	39.4	35.3	37.1	31.2	34.2	38.1
June	39.0	35.4	37.5	32.3	34.1	35.2
July	39.0	36.4	35.8	34.0	32.0	34.0
August	35.7	34.6	34.7	33.6	31.6	32.7
September	36.0	34.0	35.0	35.0	32.7	32.2
October	36.2	34.2	34.3	32.1	32.2	31.8
November	35.9	32.9	33.8	30.7	31.8	31.2
December	34.7	32.7	33.9	30.9	31.7	31.8
1888—January	35.6	32.5	33.7	30.5	31.5	32.2
February	34.3	32.4	32.5	31.0	31.0	32.0
March	34.0	33.0	32.6	30.5	31.3	30.9
April	36.3	34.8	33.8	31.0	35.0	31.4
May	35.2	35.2	34.3	31.6	33.6	33.0
June	32.0	33.0	33.0	31.4	35.5	33.2
July	34.2	34.0	33.8	31.0	31.9	33.6
August	33.7	33.7	33.7	31.2	31.2	33.2
September	32.7	32.7	32.8	30.8	31.0	32.0
October	33.3	33.3	32.3	30.6	30.4	30.4
November	31.8	32.8	31.7	30.6	30.6	30.8
December	31.4	32.4	31.6	30.3	*29.2	30.7
1889—January	31.0	31.3	30.6	30.3	31.0	30.9
February	32.4	32.5	31.8	32.8	31.0	32.5
March	30.2	32.2	30.4	32.3	31.8	31.6
April	30.8	32.1	31.2	32.8	31.8	30.6
May	30.8	32.0	30.7	32.6	31.2	30.8
June	30.4	32.2	31.3	31.5	31.0	30.8
July	30.3	31.0	31.0	32.4	31.3	31.0
August	31.7	31.4	31.5	31.6	31.4	31.0
September	30.9	31.3	31.2	31.0	31.1	....
October	31.6	31.0	31.2	31.0	31.7	†29.6
November	31.0	31.2	31.2	31.0	31.3	31.4
December	30.8	31.0	31.2	31.0	31.7	31.2
1890—January	30.8	30.8	31.2	30.6	31.0	31.0
February	31.7	30.7	31.5	32.6	34.4	33.0
March	36.4	33.2	34.0	34.0	34.0	33.6
April	33.4	36.0	35.0	35.0	38.7	34.5
May	32.0	34.0	34.0	36.0	39.0	34.0
June	32.0	33.5	33.0	34.0	39.8	35.0
July	32.4	33.4	34.0	34.0	39.0	37.0
August	32.0	33.0	33.0	32.7	35.0	34.0
September	30.5	31.4	33.0	33.0	35.0	33.0
October	32.0	31.0	31.0	30.5	34.0	32.8
November	30.6	31.2	30.6	30.6	34.0	33.0
December	31.5	31.2	31.0	30.7	32.3	33.5
1891—January	31.0	31.0	31.2	32.2	32.8	32.5
February	31.7	31.0	31.4	32.5	35.2	32.7
March	32.0	34.3	36.4	37.5	36.0	34.6
April	‡30.5	32.0	36.5	39.0	36.4	34.2
May	‡30.3	‡32.0	32.0	35.0	36.0	34.0
June	33.0	31.1	32.0	34.7	37.0	35.0
July	31.4	30.4	30.4	33.3	35.8	34.8
August	31.0	31.0	31.0	32.3	32.9	31.4
September	30.6	30.6	30.7	31.0	31.5	....
October	31.0	30.8	30.8	31.2	31.2	30.7
November	31.2	31.0	31.3	31.2	31.1	30.6
December	30.1	30.3	30.6	31.4	31.3	32.0
1892—January	31.3	31.6	31.3	31.3	31.8	32.2
February	30.5	30.8	30.8	31.0	31.1	31.7
March	30.8	30.7	31.4	31.7	31.2	31.0
April	32.0	32.0	33.7	32.0	30.5	30.6
May	§28.1	§29.6	38.0	35.0	33.0	32.0
June	§30.4	32.3	36.0	37.0	36.6	33.2

* From December 28, 1888, to January 4, 1889, inclusive.
† From October 1 to October 5, inclusive.
‡ Depth less than 30 feet from April 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.
§ Depth less than 30 feet from May 20 to June 20, both dates inclusive, and varied from 28.1 to 29.6 feet.

The shoal area east of the east jetty is gradually but slowly deepening, and the land formation east of this jetty is rapidly receding. During the past year this recession averaged 250 feet.

SURVEY BEYOND THE ENDS OF THE JETTIES IN THE GULF OF MEXICO.

The chart of this survey is No. 2. Following the methods which have been used for many years, and which are fully explained in previous reports, I find by measuring ordinates to each curve from 20 to 100 feet, inclusive, obtaining their means, and comparing them with results similarly obtained one year ago, that each advanced during the year, the 20-foot curve showing the least advance, of 55 feet, and the 30-foot curve the greatest, being 240 feet.

The results of these determinations are given on chart No. 7 in such a way that the changes in each of these curves from year to year since 1876 may be readily followed and understood.

The most interesting comparisons are usually between the earliest and latest results. These are given on the diagram, page 1479, from which it will be seen that from 1877 to 1892 each curve advanced; that is, the same depth of water is a greater distance from the ends of the jetties than in 1877. For example, the depth of 70 feet is 1,555 feet farther from the ends of the jetties, that of 20 feet 810 feet farther, etc., than in 1877.

Since preceding determinations show that each curve advanced during the year, and since 1876, it follows that a shoaling has taken place beyond the ends of the jetties. The mean vertical height of this shoaling over an area containing 1¼ square miles, for each year from 1876 to 1892, is as follows:

Years.		Mean change over whole area.		Years.		Mean change over whole area.	
From—	To—	Deepened—	Shoaled—	From—	To—	Deepened—	Shoaled—
		Feet.	*Feet.*			*Feet.*	*Feet.*
1876	1877	....	0.40	1885	1886	....	0.12
1877	1878	1.80	....	1886	1887	....	1.38
1878	1879	....	2.56	1887	1888	....	0.31
1879	1880	0.12	....	1888	1889	1.23	....
1880	1881	....	2.38	1889	1890	....	1.11
1881	1882	....	1.30	1890	1891	....	2.70
1882	1883	0.04	....	1891	1892	....	1.59
1883	1884	....	3.61				
1884	1885	1.16	....	1876	1892	....	13.11

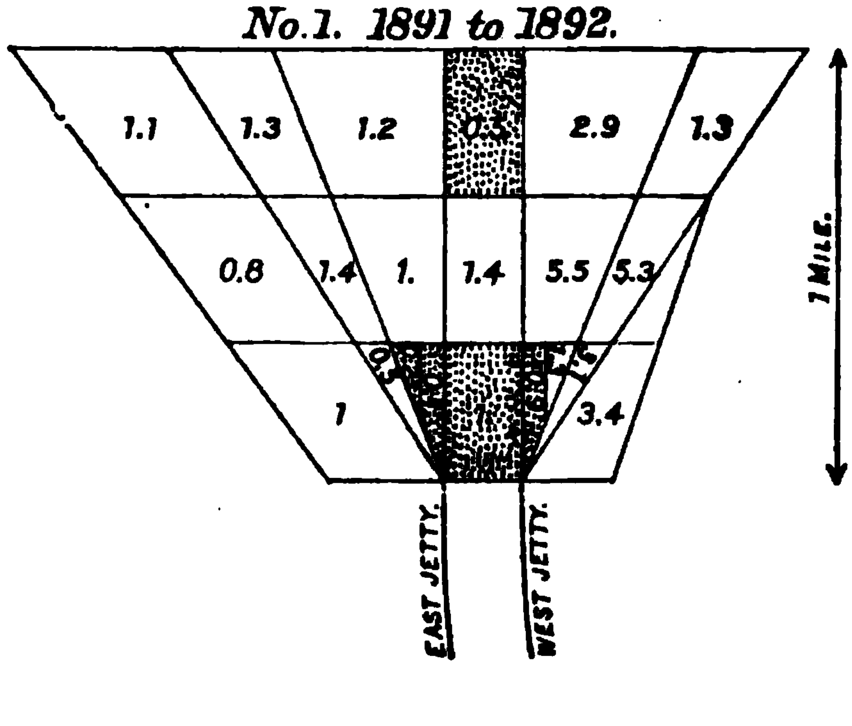
Now, in order to locate definitely areas which are undergoing the greatest or least change, this area of 1¼ square miles is divided into 21 lesser areas, the mean depth of water in each is obtained, and by comparison with earlier results similarly obtained the vertical height of the shoaling or deepening in each area becomes known.

The following diagrams furnish this information. The figures in each area are the differences, in feet and tenths, between the mean depths obtained for the years between which comparisons are made and denote the amount of the shoaling or deepening in each.

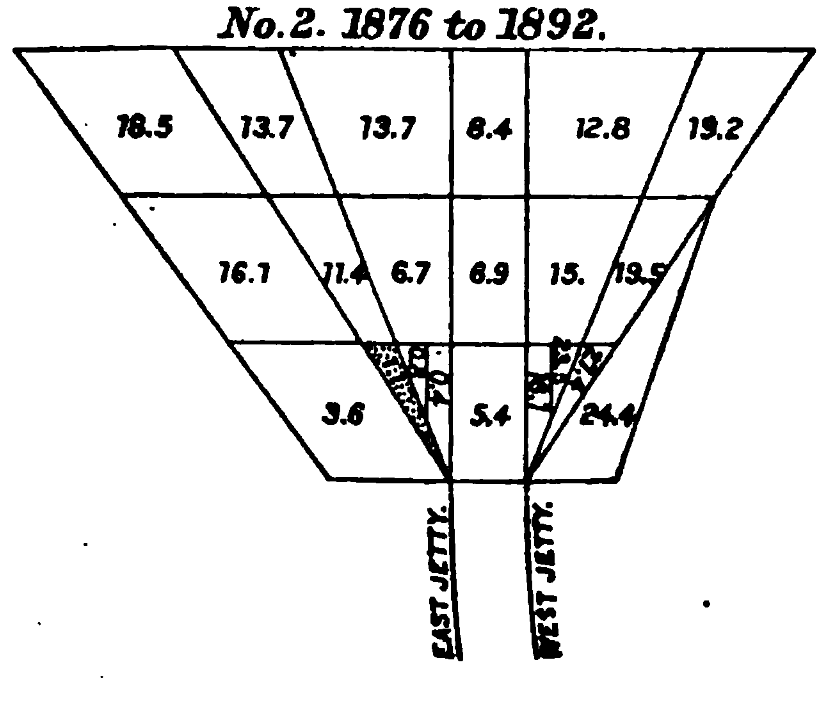
No. 1 compares the mean depths in 1891 with those in 1892, and No. 2 compares those in 1876 with those in 1892.

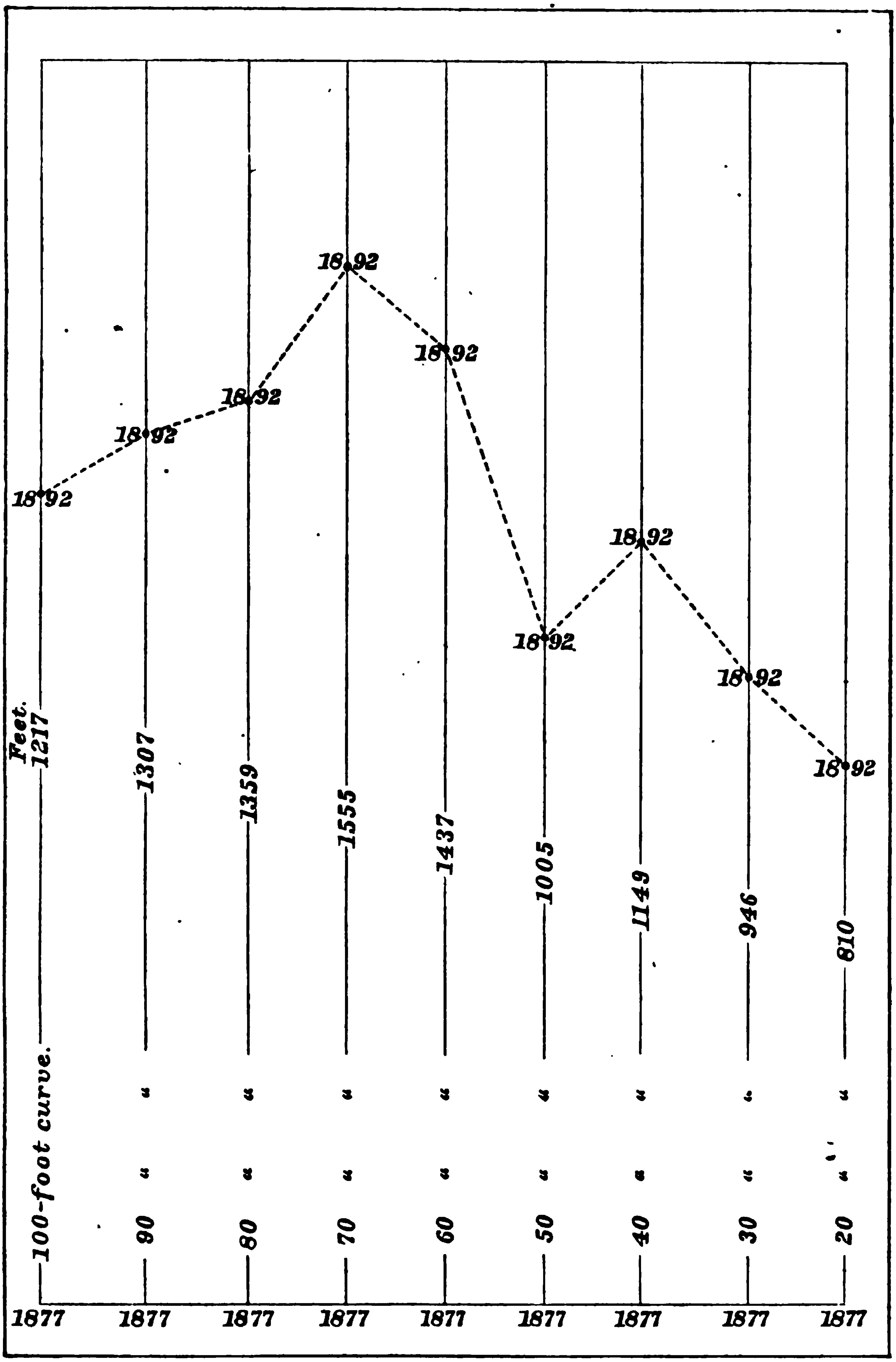
Dotted areas have deepened; all others have shoaled.

No. 1. 1891 to 1892.



No. 2. 1876 to 1892.




Feet.
100-foot curve.
90 " "
80 " "
70 " "
60 " "
50 " "
40 " "
30 " "
20 " "
1217
1307
1359
1555
1437
1005
1149
946
810
1877
1892

It will be seen that the two most westerly of the central areas shoaled the greatest amount during the year. This no doubt is, to a great extent, due to the fact that the dredged material taken from the channel during the year was dumped in that vicinity.

LOSS OF THE BARK CHARLES LULING.

On the 5th of April the German bark, *Charles Luling*, with a cargo of 3,000 barrels of cement, and drawing 16 feet, grounded to the westward of and beyond the end of the west jetty. She was in charge of a bar pilot, who undertook to sail her into the jetty channel from sea. The wind was strong and fair, but when the strong current of the pass was met the vessel sheered to the westward; an anchor was let go, but the force with which she was going was so great that the chain parted, and before anything further could be done she was hard aground. It is altogether probable that the sheer was caused by the vessel being kept on such a course as to take the strong current of the pass so much on her starboard bow that the force of the latter proved greater than her propelling force, in which case a sheer would be inevitable.

A heavy sea was running at the time, and continued during the next day, the vessel cutting to the westward rapidly, and becoming imbedded in the sand. On the 7th two towboats rendered assistance, but by this time she was leaking badly, and had commenced to settle into the sand, so that it was impossible to save her, and after removing her stores, furniture, etc., she was abandoned. The location of her wreck is given on chart No. 2.

CONCLUSION.

During the year I was faithfully and efficiently assisted by Recorder G. W. Lawes, whom I desire to commend.

Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

APPENDIX S.

IMPROVEMENT OF CERTAIN STREAMS IN LOUISIANA, AND OF HARBOR AT SABINE PASS, SABINE RIVER, AND NECHES RIVER, TEXAS.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chefuncte [Tchefuncte] River and Bogue Falia, Louisiana.
2. Tickfaw River and its tributaries, Louisiana
3. Amite River and Bayou Manchac, Louisiana.
4. Bayou La Fourche, Louisiana.
5. Bayou Terrebonne, Louisiana.
6. Bayou Plaquemine, Louisiana.
7. Bayou Courtableau, Louisiana.
8. Bayou Teche, Louisiana.
9. Mouth and passes of Calcasieu River, Louisiana.
10. Harbor at Sabine Pass, Texas.
11. Sabine River, Texas.
12. Neches River, Texas.
13. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

14. Sabine River, from Sabine Lake to Sudduths Bluff, Texas.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 6, 1892.

GENERAL: I have the honor to transmit herewith annual reports * * * upon works of river and harbor improvement at present in my charge for the fiscal year ending June 30, 1892.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

S 1.

IMPROVEMENT OF CHEFUNCTE (TCHEFUNCTE) RIVER AND BOGUE FALIA, LOUISIANA.

The project for the improvement of this river was adopted in 1880, and contemplated the removal of obstructions in the channel, such as snags, logs, and overhanging trees, and the dredging of the bar at the river's mouth.

With the two appropriations made in 1881 and 1882 of $1,500 each, the obstructions below Covington were removed, and part of the unexpended balance was used for the construction of a working plant for improving the bar at the mouth, and part for the construction of 820 feet of breakwater.

August 5, 1886, Congress made an appropriation of $2,500 for this work, and in 1887 channels were cut through the bars between Covington and Old Landing 5 feet deep and 30 to 60 feet wide, giving better navigation for schooners between these places.

The original estimated cost of improving this river was $5,460, the greater portion of which was for dredging the bar at its mouth.

It was thought, however, that a dredged channel over this bar could not be maintained without protecting works, which would cost considerably more than the dredging. Maj. Stickney, who had charge of this work, caused a reëxamination to be made in 1884, and in his report in the Annual Report of the Chief of Engineers for 1884, Vol. II, page 1269, he reports the river in good order, except the bar at its mouth, and suggests as a method of improving this to build a jetty or breakwater 2,500 feet long across the bar into the comparatively deep water of Lake Pontchartrain, and then to dredge the channel through the bar, in the hope that the jetty would prevent, or at all events greatly retard, the refilling of the cut with sand.

Under the appropriation of $1,000 made September 19, 1890, the work of removing obstructions in the channel was commenced in October, 1891, using the snagging plant which had shortly before ceased operations on the Tickfaw River.

Snags, logs, and impending trees were removed from the channel of the river from Madisonville to Old Landing, and from the latter place to Covington on the Bogue Falia, as far as the funds on hand would permit. The principal obstructions removed from the channel during the year were: 161 snags, 82 overhanging trees, 61 landslide trees, 58 stumps, 44 logs, and 29 tree tops. The work was discontinued November 30, 1891.

The snag and quarter boats were in such bad condition that the property was removed from them, and both the property and boats were placed in charge of a watchman at Madisonville.

The total amount expended on these streams to June 30, 1892, was $6,289.26.

The river now has a navigable depth of 5 feet to Old Landing, and from there to Covington the Bogue Falia is navigable for the lighter-draft schooners.

It will cost about $1,000 each year to keep this river and bayou free of obstructions.

Abstract of appropriations for improving Chefuncte (Tchefuncte) River and Bogue Falia, Louisiana.

By act of Congress approved March 3, 1881	$1,500
By act of Congress passed August 2, 1882	1,500
By act of Congress approved—	
August 5, 1886	2,500
September 19, 1890	1,000
Total	6,500

Money statement.

July 1, 1891, balance unexpended	$1,000.00
June 30, 1892, amount expended during fiscal year	789.26
July 1, 1892, balance unexpended	210.74
Amount appropriated by act approved July 13, 1892	1 000.00
Amount available for fiscal year ending June 30, 1893	1,210.74
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Sailing vessels, number of trips made	364
Registered tonnage of same	6,552
Steam vessels, number of trips made	3
Registered tonnage of same	96

Average draft of sailing vessels, light, 2 feet; loaded, 5 feet 9 inches; of steamers, light, 2 feet; loaded, 4 feet.

There were no new lines of transportation established during the past year.

Receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Lumber	11,202	$56,010	16,188	$109,272
Shingles	3	60	1	21
Staves	1,802	7,725	292	234
Brick	1,157	5,679	4,540	14,528
Sand	11,499	10,242	11,566	12,845
Wood	8,388	20,845	4,475	13,715
Charcoal	10,920	97,500	204	272
Cotton			597	89,582
Laths			95	433
Rice			276	7,745
Miscellaneous	130	3,000	270	4,699
Receipts.				
Estimated at			11,550	101,338
Total	45,521	201,061	50,054	354,684
Increase of 1891-'92 over 1890-'91			4,533	153,623

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1890	27,803	$173,283
1891	45,521	201,061
1892	50,054	354,684

S 2.

IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISIANA

This work was commenced in 1879 by an examination authorized by Congress. The estimated cost of the improvement was $10,230, and the project was to clean out this stream as well as its navigable tributaries, the Natalbany, Blood, and Ponchatoula rivers, by removing obstructions to navigation such as snags, logs, stumps, and overhanging trees.

In 1881 $2,000 was appropriated with which to commence work. The work under this appropriation was done by contract in 1882, and 16 miles of the Tickfaw were cleaned out.

In 1882 Congress appropriated $2,000 more. This was expended partly in building plant, and the work of cleaning out the stream was done with this plant and hired labor. The result was a good navigable channel 9 miles above the previous head of navigation on the Tickfaw.

In 1886 an appropriation of $2,000 was made, the funds to be used for cleaning out the navigable branches of the Tickfaw. In the latter part of 1886 and early part of 1887 work was resumed with the Government plant and hired labor, and the branches cleared to the head of navigation.

In 1888 an appropriation of $1,000 was made for improving the Tickfaw and its navigable tributaries. The latter being in good condition, the snagging plant commenced work on the river itself in May, 1889, removing the obstructions that had reformed since 1887, and worked upstream to within 1 mile of the Chapman place, where operations ceased.

In 1890 $1,000 was appropriated for continuing the improvement. In September, 1891, work was commenced with the Government snagging plant and hired labor. The obstructions which had reformed since 1889, such as snags, logs, overhanging trees, etc., were removed from the Tickfaw, Natalbany, and Blood rivers, the latter being cleared to the head of navigation. About 39 miles of channel had been improved when work ceased October 12, 1891. The obstructions removed from the rivers during the year were: 83 snags, 71 overhanging trees, 32 landslide trees, 14 logs, 9 tree tops, and 1 stump.

The improvement is not permanent, since logs and snags find their way into the channel which require removal from time to time. About $1,000 will be required annually to keep the navigable channel in condition.

To the close of the year ending June 30, 1892, there has been expended on these streams the sum of $7,777.96.

Abstract of appropriations for improving Tickfaw River and its tributaries, Louisiana.

By act of Congress—	
Approved March 3, 1881	$2,000
Passed August 2, 1882	2,000
Approved August 5, 1886	2,000
Passed August 11, 1888	1,000
Approved September 19, 1890	1,000
Total	8,000

A material increase in the receipts and shipments has been made as a result of the improvement already accomplished.

Money statement.

July 1, 1891, balance unexpended	$1,000.00
June 30, 1892, amount expended during fiscal year	777.96
July 1, 1892, balance unexpended	222.04
Amount appropriated by act approved July 13, 1892	1,000.00
Amount available for fiscal year ending June 30, 1893	1,222.04
Amount that can be profitably expended in fiscal year ending June 30, 1894 / Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,000.00

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Sailing vessels, number of trips made	119
Registered tonnage of same	2,142
Number of steamers	2
Registered tonnage of same	626
Number of trips made by steamers	8

Average draft of sailing vessels, light, 2 feet; loaded, 5 feet 9 inches; of steamers, light, $2\frac{1}{2}$ feet; loaded, $5\frac{1}{4}$ feet.

No new lines of transportation were established during the year.

Comparative statement of receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Wood	116	$475	1,200	$8,440
Lumber	185	1,466	6,792	42,770
Bricks			537	1,720
Staves			30	630
Cotton			121	21,975
Miscellaneous freight			95	3,581
Total	301	1,941	8,775	79,116
Receipts.				
Estimated value of sundry merchandise taken to the Tickfaw River			2,632	23,000
Total	301	1,941	11,407	102,116
Increase over previous year			11,106	100,175

S 3.

IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

The original project for the improvement of this river was adopted in 1880, which contemplated a channel 5 feet in depth as far upstream as appropriations would permit, the main part of the work to be done above the mouth of the Bayou Manchac.

In 1883, owing to the unsatisfactory manner of doing the work by contract, the project was amended so to provide for the removal of obstructions below the Manchac by the Government plant and hired labor, and resulted in a satisfactory improvement of about 8 miles of the river.

In 1886, under an appropriation of $2,000, work with Government plant and hired labor was resumed, and the logs and snags removed from about 5 miles of river below the mouth of the Bayou Manchac, leaving the Amite River in good navigable condition.

In 1888, $5,000 was appropriated with the stipulation that half of this sum might be used in improving Bayou Manchac, and in November, 1888, work with the Government plant and hired labor was commenced in this bayou, working up from its mouth to Hereford Landing, leaving the Manchac in good condition up to that point. The plant was then taken back to the Amite River, and from it removed the snags, logs, and impending trees which obstructed the channel.

In 1890, $3,800 was appropriated for the completion of the old project, the money, however, to be applied to the Amite or Manchac in such proportions as the engineers might deem best. Work was resumed in October, 1890, with the Government plant at Hope Villa, on the Manchac, and the bayou cleaned up for a distance of about 3 miles, when the plant turned back, and, commencing at Wards Creek, worked down stream to the Amite River.

During the year just closed the work of removing the obstructions in the channels was continued until August 29 last, when operations were discontinued and the snagging plant towed to the Tickfaw River for work on that stream.

Snags, logs, and impending trees were removed from the Bayou Manchac between its mouth and Hope Villa, and from the river between its mouth and the mouth of the Bayou Manchac.

The principal obstructions removed from the river and bayou during the year were: 269 snags, 69 trees, 42 logs, 24 stumps, 11 tree tops, and 11 overhanging trees.

The improvement is not permanent, since logs and stumps are continually getting into the bayou and Amite River, forming snags and obstructions that will require removal from time to time to preserve the navigation.

About $2,500 will be required each year to keep this river and bayou in navigable condition.

There has been expended on these streams to June 30, 1892, the sum of $23,628.15.

Abstract of appropriations for improving Amite River and Bayou Manchac, Louisiana.

By act of Congress approved—	
June 14, 1880	$8,000
March 3, 1881	5,000
August 5, 1886	2,000
By act of Congress passed August 11, 1888	5,000
By act of Congress approved September 19, 1890	3,800
Total	23,800

Money statement.

July 1, 1891, balance unexpended	$1,122.14
June 30, 1892, amount expended during fiscal year	950.29
July 1, 1892, balance unexpended	171.85
Amount appropriated by act approved July 13, 1892	2,500.00
Amount available for fiscal year ending June 30, 1893	2,671.85
Amount that can be profitably expended in fiscal year ending June 30, 1894 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,500.00

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Number of steamers	4
Number of trips	316
Registered tonnage of steamers, 316 trips	7,036
Sailing vessels, number of trips made	73
Registered tonnage of same	1,387

Average draft of sailing vessels, light, 2 feet; loaded, 5 feet 9 inches; of steamers, light, 2½ feet; loaded, 5½ feet.

There were no new lines of transportation established during the last year.

Receipts and shipments for two years.

Articles.	Year ending May 31, 1891. Tons.	Year ending May 31, 1891. Value.	Year ending May 31, 1892. Tons.	Year ending May 31, 1892. Value.
Shipments.				
Lumber	7,751	$62,820	4,838	$32,641
Shingles	350	5,985	656	14,206
Bricks	216	782	....	....
Wood	1,526	4,115	5,231	8,405
Staves	1,512	5,850	388	1,764
Laths	156	4,014	464	2,104
Sand	4,916	4,214	....	....
Cotton and seed	1,221	205,728	1,619	174,090
Miscellaneous freight	165	7,405	40	5,405
Total	17,792	300,963	13,236	238,615
Receipts.				
Estimated at	....	....	5,294	95,446
Total	17,792	300,963	18,530	334,061
Increase over previous year	....	....	738	33,098

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1890	84,295	$291,667
1891	17,792	300,963
1892	18,530	334,061

S 4.

IMPROVEMENT OF BAYOU LAFOURCHE, LOUISIANA.

In 1879 a project was approved for removing the obstructions to navigation in the bayou, such as snags, wrecks, raft heaps, and impending trees. Work was carried on under this project from 1881 until 1883, when the plant was laid up at Lockport after clearing the bayou a distance of 30 miles below that point.

In 1884 a project was approved for continuing the snagging operations on down beyond the place where work had ceased in 1883, and accordingly work was resumed in September, 1884, and continued to January, 1885, when operations were suspended on account of high water. The plant was subsequently removed to other places.

Beyond surveys and examinations, nothing further was done until 1888, when Congress appropriated for "improving Bayou Lafourche,

Louisiana, pursuant to the project of Lieut. O. T. Crosby, Corps of Engineers, dated June 11, 1886, $50,000, including immediate dredging to secure low-water navigation."

During eight months of the year, when the Mississippi River is high, Bayou Lafourche is navigable by the largest steamboats, but during extreme low-water navigation is sometimes entirely suspended for flatboats drawing over 2 feet of water.

The project referred to in the foregoing act was to place a lock in the Mississippi River end of the bayou, converting the bayou into a slack-water stream, and then dredge a channel 75 feet wide and 5 feet deep at mean low water of the Gulf throughout its length.

The act also provided for immediate dredging, and since the bar at the river end of the bayou had shut out navigation in 1887, it was proposed to dredge a channel through this bar, the channel to have a depth of 4 feet below mean low water of the Gulf, and a width of 60 feet. This dredging was done by contract and admitted sufficient water to the bayou to reëstablish flatboat navigation, which had been suspended a day or two while the cut was being made.

It having been ascertained that about 150,000 cubic yards of material would have to be dredged from the bayou to secure 2 feet depth for flatboat navigation, bids were opened June 10, 1889, for dredging this amount, but the price bid was deemed too high and the bid was rejected. Work was then begun by a hired dredge and continued until high water interfered.

The channel had been carried a distance of about 2 miles from the mouth, and had a depth of 2 to 3 feet at mean low water of the Gulf. Upon commencing this dredging it was found that the channel through the bar at the head of the bayou had shoaled so as to require redredging, and much of the channel work had to be gone over several times, owing to the caving of the sides of the cut. On September 15, 1890, dredging was resumed. The dredge had, as formerly, to reopen the cut through the bar at the head of the bayou and redredge much of the channel previously gone over. The work was suspended in January, 1891, owing to high water.

Upon the subsidence of the high water, work was resumed on August 5, 1891, and continued until high water again caused its suspension, in the latter part of January, 1892.

During this time the dredge removed from the channel 95,984 cubic yards of material, 48 stumps, 33 logs, and 10 wrecks, making flatboat navigation practicable for a distance of about 32 miles during low water.

Work will be commenced again as soon as the stage of water will permit.

The improvement by dredging is a slow and unsatisfactory way, since the silting up of the dredged channel takes place with the recurrence of high water each year. The construction of a lock at the head of the bayou will almost entirely overcome this difficulty and render the navigation of the bayou safe and certain under all conditions of tide in the Mississippi River.

The cost of a lock at Donaldsonville was estimated by Lieut. Crosby to be about $450,000. With this lock completed, whatever dredging was done in the bayou thereafter would be practically permanent, and a moderate annual outlay would maintain satisfactory navigation hardly possible to secure with any amount of money under the present conditions.

The total amount expended on the improvement of this bayou to June 30, 1892, was $73,343.80.

Abstract of appropriations for improving Bayou Lafourche, Louisiana.

By act of Congress approved—	
June 18, 1878	$10,000
March 3, 1879	10,000
June 14, 1880	5,000
July 5, 1884	5,000
By act of Congress passed August 11, 1888	50,000
By act of Congress approved September 19, 1890	50,000
Total	130,000

Money statement.

July 1, 1891, balance unexpended	$72,716.56
June 30, 1892, amount expended during fiscal year	16,060.36
July 1, 1892, balance unexpended	56,656.20
July 1, 1892, outstanding liabilities	175.00
July 1, 1892, balance available	56,481.20
Amount appropriated by act approved July 13, 1892	50,000.00
Amount available for fiscal year ending June 30, 1893	106,481.20
Amount (estimated) required for completion of existing project	350,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Number of steamers	8
Total registered tonnage	2,335
Aggregate number of trips out of bayou	253
Aggregate tonnage of same	79,488
Sailing vessel	1
Registered tonnage of same	10
Aggregate number of trips out of bayou	21
Aggregate tonnage of same	210
Number of barges entering the bayou	108
Aggregate tonnage of same	91,320

Number of lines of steamers, 6; one line of 3 vessels, and 5 steamers running independent.

Average draft of steamers: Light, 2 feet; loaded, 9¼ feet.

There were no new lines of transportation established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Sugar	44,832	$3,290,481	26,330	$2,531,155
Molasses	31,984	968,000	17,334	510,250
Rice	8,310	326,736	3,337	162,978
Potatoes and onions	4,709	151,447	2,738	73,032
Eggs	111	2,505	159	16,308
Moss	205	12,270	196	9,825
Pecans	77	5,190	4	2,100
Miscellaneous freight	475	35,466	275	7,441
Total	90,703	4,792,095	50,373	3,313,089
Receipts.				
Miscellaneous freight	54,420	3,194,730	32,562	1,991,853
Coal	72,150	257,400	88,920	355,680
Grand total	217,273	8,244,225	171,855	5,660,622

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1890	200,746	$5,709,382
1891	217,273	8,244,225
1892	171,855	5,660,622

During the season of extreme low water, when the bars that have formed in the bayou prevent the running of steamboats, a large portion of the sugar and rice crops are transported up the bayou, by means of flatboats, to the head, where it is reshipped on the regular bayou boats and brought to New Orleans by way of the Mississippi River.

During the last year thirty-three flatboats and two small steamers were engaged in this business. The flatboats carried cargoes of from 25 to 85 tons, and the steamboats from 50 to 70 tons. The number of trips made or the total of cargo handled by this means can not be ascertained at this time.

There are also two little boats, of 25 and 75 tons capacity, that are making regular passenger trips up and down the bayou between Donaldsonville and Thibodeaux, both railroad points and distant 34 miles one from the other.

S 5.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

Previous to the commencement of the improvement of the Bayou Terrebonne it was little better than a drainage ditch in places.

The project adopted for the improvement of this bayou contemplated the dredging of a channel 4 feet deep at mean low water of the Gulf to Houma, and, with the appropriation of $10,000 made in 1880, the work of dredging was commenced in that year and continued until December 17, 1887, when the channel was completed to the railroad depot at Houma, where a turning basin was dug.

The improvement enables planters on the bayou to float their produce to Houma, the nearest railroad station, or else ship by boat direct to New Orleans by way of connecting bayous and canals.

It is doubtful if the improvement can be made permanent, as more or less silt finds its way into the bayou, causing shoals to form, which will require removal from time to time.

No work has been done during the past year, and it is not believed that more work will be required during the ensuing year than can be secured with the funds remaining available.

The estimated cost of the improvement was $38,800. The completion of the project has cost $35,808, leaving $2,992 still unexpended.

Abstract of appropriations for improving Bayou Terrebonne, Louisiana.

By act of Congress approved—	
June 14, 1880	$10,000
March 3, 1881	8,800
By act of Congress—	
Passed August 2, 1882	7,000
Approved August 5, 1886	10,000
Passed August 11, 1888	3,000
Total	38,800

Money statement.

July 1, 1891, balance unexpended	$2,992.00
July 1, 1892, balance unexpended	2,992.00

COMMERCIAL STATISTICS.

Owing to the crevasse of last year the Terrebonne section away from the railroad, nearly all of it, was inundated, and the crops produced amounted to so little that the boat usually plying in the bayou had to seek another trade, which compelled the producers to haul to and from the railroad.

The statistics printed in the last Annual Report are appended.

Number of vessels, 1889-'90	2
Total registered tonnage of same	76.20
Aggregate number of trips out of bayou	29
Aggregate tonnage of same	326.45

Articles.	Year ending May 31, 1889.		Year ending May 31, 1890.	
	Quantity.	Value.	Quantity.	Value.
Shipments.				
Sugar .... barrels..	11,623	$209,214	8,745	$157,410
Molasses .... do....	4,443	35,544	3,586	28,688
Rice .... sacks..	250	812	350	1,137
Potatoes .... do....	258	516	350	700
Moss .... bales..	12	72	24	144
Total .... tons..	3,076	....	2,394	....
Receipts.				
Coal .... tons..	1,000	5,000	1,500	7,500
Miscellaneous freight	1,340	179,000	1,160	133,000
Total .... tons..	5,416	430,158	5,054	328,579

S 6.

IMPROVEMENT OF BAYOU PLAQUEMINE, LOUISIANA.

Prior to 1867 or 1868 Bayou Plaquemine was navigated by the largest steamboats, but sometime during the year mentioned the police jury of Plaquemine, without any apparent warrant of law, caused a dike to be built across this bayou, shutting out the water of the Mississippi River.

Steamers which had used the Plaquemine route to Grand Lake and the Teche country were thereafter obliged to go by way of the mouth of the Red River and the Atchafalaya to reach their districts, and for some time past have been entirely cut off from communication by this roundabout way on account of the closing of the mouth of Red River at low water. The opening of this bayou to navigation is therefore of importance to the navigation of the Red, Black, Ouachita, and Atchafalaya rivers, and the bayous Tensas, Bartholomew, Macon, Boeuf, Cypress, Teche, and Courtableau, the natural water transportation routes of a very fertile and very large area of rapidly improving country.

In 1885 a project for the improvement of this bayou, by building a lock to connect it with the Mississippi River and clearing out the chan-

nel so as to give a depth of 6 feet at mean low-water level of the Gulf, was presented. This improvement was estimated to cost $1,708,250.

In 1888 $100,000 was appropriated "for securing a navigable channel 60 feet wide and 6 feet in depth from deep water up to the Plaquemine Dike, and for securing the mouth of the bayou from further caving."

As there was no plant at the disposal of this office for the construction of dikes, etc., $75,000 of this appropriation was allotted for the construction of bank protections and turned over to the officer in charge of the fourth district of the Mississippi River in May, 1889.

With the remainder of the funds dredging was commenced June 4, 1889, at a point about 5 miles below the town of Plaquemine, the work being done with a dredge belonging to the United States and hired labor. This dredging was continued up to date, with short interruptions due to high water.

Owing to the railroad bridge at Plaquemine not being a drawbridge, it has not been possible to continue the dredging up to the Plaquemine Dike, as specified in the act of appropriation. The project was accordingly modified so as to stop dredging when the railroad bridge was reached.

As soon as the bridge was reached the dredge turned back and worked down to a point about one-half of a mile from it, when work was discontinued and the plant laid up at Plaquemine and placed in charge of a watchman.

The work done from July 1 to August 31, 1891, resulted in the excavation of 19,716 cubic yards of material and the removal from the channel of 139 logs and 28 stumps.

In 1890 $100,000 was appropriated for continuing the work of improvement of this stream. Forty thousand dollars was allotted to this office, the rest being allotted for bank protection, as in the case of the preceding appropriation.

Under this last allotment of $40,000 a project for the commencement of work upon a lock to connect the Mississippi River with the bayou was presented, and a board of engineer officers was appointed to consider the subject.

Under the direction of this board plans for a lock of sufficient size to pass four coal boats or the largest steamer which would be liable to make use of it at one lockage were prepared. The estimated cost of this lock, with the required right of way and approaches, is $700,000.

As the $40,000 available was not sufficient to warrant the commencement of work upon the lock, it has been held subject to an increase.

Since the bayou is not navigated by vessels engaged in the transportation of merchandise, owing to the communication with the Mississippi River being cut off, the commercial statistics give no indication of the importance of this water route when communication with the Mississippi River shall have been established.

The amount expended on the improvement of the bayou to June 30, 1892, from funds allotted to this office, was $23,830.72, $1,000 of which was expended for preliminary examinations and surveys from the allotment of $75,000 for bank protection at the mouth of the bayou.

Abstract of appropriations for improving Bayou Plaquemine, Louisiana.

By act of Congress—	
Passed August 11, 1888	$100,000
Approved September 19, 1890	100,000
Total	200,000

*Money statement.**

July 1, 1891, balance unexpended	$132,063.43
June 30, 1892, amount expended during fiscal year	58,776.34
July 1, 1892, balance unexpended	73,287.09
Amount appropriated by act approved July 13, 1892	150,000.00
Amount available for fiscal year ending June 30, 1893	223,287.09
Amount (estimated) required for completion of existing project	1,358,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	525,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The crops and supplies of the people residing along the Bayou Plaquemine have to be hauled by wagon to and from the Mississippi River.

Shipments for two years.

Articles.	June 1, 1890, to May 31, 1891.		June 1, 1891, to May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Sugar	1,870	$132,600	1,122	$92,800
Molasses	1,629	71,600	1,141	50,120
Moss	50	2,500	55	2,750
Miscellaneous freight			927	58,268
Total	3,549	206,700	3,245	203,938

The cypress and other logs towed into the Bayou Plaquemine by small steamers and sawed into lumber, lath, and shingles, by the seven sawmills along the bayou, amounted to 63,315,000 feet, or 126,630 tons, valued at $1,139,670. Nearly all of this product was hauled to and shipped by river.

REPORTS OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, AND OF BOARD OF ENGINEERS, ON LOCK AT MOUTH OF BAYOU PLAQUEMINE, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., May 25, 1891.

GENERAL: In obedience to instructions contained in letter from your office dated February 19, 1891, I have the honor to submit the following project for the expenditure of the $40,000 available for improving Bayou Plaquemine, Louisiana, with plans and drawings* for a lock to connect the bayou with the Mississippi River, and estimates of cost of a lock 265 feet between perpendiculars, 52 feet wide, and lock-walls 42 feet high.

I also forward drawings † of proposed locks for this locality which were turned over to me by my predecessor, Capt. W. L. Fisk, Corps of Engineers.

*This money statement includes amounts for securing mouth of Bayou Plaquemine from further caving. (Appendix T 1.)

† Not printed.

LOCATION.

Several locations for this much-needed lock were recommended, but it appears to me that in every case the local interests of the place have been ignored. Referring to map of Plaquemine and vicinity, two of the suggested sites are shown by shaded areas, numbered 1 and 2. Both situations are influenced apparently by a supposed necessity to economize the old mouth of the bayou, and some stress is also laid upon the positions giving a more direct entrance into the bayou at the railroad bridge. I have discussed the subject of location with steamboat men and citizens of Plaquemine and it does not appear that such sites are entirely satisfactory. The old mouth of the bayou has almost entirely silted up and the location of the railroad and the condition of the bayou beyond are not favorable for a landing port. Owing to the mouth having silted up the amount of excavation is very great. A large amount of this excavation would have to be done before any work upon the lock proper could be commenced, and the disposal of the excavated material would be expensive if not a source of considerable embarrassment. I inclose a photograph * of this site A as viewed from below the railroad bridge, looking very nearly in the direction of the axis of site No. 2.

NEW SITE.

From the practical stoppage of the caving of the bank at Plaquemine since the protection jetties were built I have faith in the ability of the jetties to preserve the bank, or at least to greatly retard the encroachment of the river, and I believe a shorter entrance to the lock may be safely had, consequently a very great economy in the maintenance of the entrance may be secured. By taking advantage of the pit already formed by the bayou a great saving in excavation may be obtained, and what is of far more importance the success of the enterprise will be better assured if speedy work upon the lock can be had without considerable outlay for excavation and preliminary work which is not so impressive to the average observer and consequently a source of discontent to those interested in the progress of the work.

I consequently recommend the placing of the lock in the bed of the bayou in front of the public square, as shown on the map. If it is found impossible to hold the bank of the river it is hardly likely that the lock would be endangered for seventy years or more, taking the progress of the cutting to be equal to that which has occurred since 1819. The basin in rear of the lock would afford the necessary space for the transaction of the shipping business of the place and give room for the arrangement of the tows of coal and produce barges preliminary to the navigation of the bayou beyond.

I send herewith a photograph* of the proposed location, B.

CHARACTER OF THE SITE.

By locating the lock in the bed of the bayou the excavation of the pit can be most economically done by floating dredges, the material excavated being conveniently deposited in the bed of the bayou where it will be needed. The soil is firmer than that upon which the city of New Orleans is built and will consequently support safely any load

* Not printed.

which is safely borne by the soil at New Orleans, and if the experience in building a lock somewhat similar a short distance below New Orleans is applicable, but little seepage may be expected after the pit has been pumped out. Mr. Ferrette, a successful architect of New Orleans, has found by experiment that a pile from 30 to 40 feet long and 12 inches in diameter will support safely a load of 67 tons if it sinks but 2 inches at the last blow of a 3,500-pound hammer with a 10-foot drop.

He thinks the supporting power of the soil at Plaquemine is considerably greater than at New Orleans. Maj. Harrod, of the Mississippi River Commission, thinks that there can be no doubt but that piles from 25 to 30 feet in length driven 4 feet from center to center and secured by concrete packed around the heads as shown in plans will be able to support safely the load proposed to be placed upon them. Col. Glenn, a contractor of New Orleans, who has had considerable experience, confirms the opinions of Mr. Ferrette. I have no hesitation in indorsing Mr. Ferrette's views, since the buildings constructed under his supervision have settled an imperceptible amount, if any, and I am confident that the character of foundation shown in the drawings will safely support the lock as designed.

THE LOCK.

The character of the site makes it advisable to distribute the load as equally as possible, and for this reason a single chamber lock is advocated. Its length between perpendiculars is 265 feet, and width 52 feet. Before adopting these dimensions a list of all the boats engaged in the navigation of the waters connecting with Bayou Plaquemine was obtained, which is herewith inclosed.*

It will be observed that the lock will hold all but one or two, a side-wheel boat and one with extra wide guards. Side-wheel boats are no longer being built for the navigation of such waters as Bayou Plaquemine, and there would be no hardship in compelling builders to conform to the proposed dimensions of lock. Two coal barges of the largest size or four of the smallest size could be locked through at once. Since all tows have to be reorganized after passing the lock but little advantage is to be had from passing more than two barges at a time. The volume of sediment-bearing water is kept within reasonable limits, and the flushing of the lock chamber is more easily effected when the dimensions of the lock are not too great, and the maneuvering of the gates is simplified. A single lift is proposed for the reason that it is believed to be feasible. The extreme fluctuations of the river surface amount to 30.5 feet above low water, and this extreme high water would last for about four months each year. By building the gates of iron, I think they can be made strong enough to withstand the pressure from this head. The lock built a short distance below New Orleans has wood-covered gates with iron beams and stands a lift of 25 feet safely.

The height of lockwall, 42 feet, is arranged to give 9 feet on the miter sill at low water and leaves about 2 feet margin for flood level.

The gates are all of the same size, since it is within the range of possibilities that a crevasse may raise the level of the water in the bayou to that of the river. The wickets are placed in the gates, and the method of maneuvering the gates is practically the same as that used in the lock below the city of New Orleans.

A drawbridge swings over the lock immediately below the lower gate. This bridge is for teams and foot passengers only.

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*Not printed.

The splay walls are full height, to guard against any leakage around their ends, and the sheet piling is carried clear across the lock and along the splay walls of both the fore and tail bays.

The walls are of concrete, faced with granite where subjected to wear.

ESTIMATES.

Concrete, at $8 per cubic foot	$160,400
Granite, at $1 per cubic foot	88,200
Gates and bridge	25,000
Piling	25,000
Lumber	10,000
Sheet piling	18,000
Excavating	60,000
Pumping and contingencies	40,000
Purchasing site	40,000
For engineering expenses	33,400
Total	500,000

RECOMMENDATIONS FOR EXPENDITURE OF AVAILABLE FUNDS.

I respectfully recommend that the $40,000 available be expended in the purchase of the land between Villier street and Fenn's alley and the river and bayou, and such other riparian rights as may be necessary.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

* * * * * * *

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 22, 1891.

Respectfully referred to the Board of Engineers constituted by Special Orders No. 41, Headquarters Corps of Engineers, June 20, 1891, for consideration and report.

The Board will furnish drawings of lock proposed or adopted by them, showing location and construction of lock in sufficient detail to enable the local engineer to build it.

These papers will be returned to this office with report of the Board.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Fifth indorsement.]

OFFICE U. S. ENGINEER,
New Orleans, La., July 17, 1891.

Respectfully returned to the Chief of Engineers, U. S. Army.

The Board of Engineer officers constituted by Special Orders No. 41, Headquarters, Corps of Engineers, U. S. Army, Washington, D. C., June 20, 1891, met at New Orleans, La., July 15, 1891, and proceeded to consider the subject of a lock at Plaquemine, La., as indicated in fourth indorsement.

For the purpose of obtaining information regarding the methods followed in the construction of canal locks in the vicinity, a visit was made to the Mexican Gulf Canal Lock, which is located about 10 miles below New Orleans.

On the following day the Board visited Plaquemine, La., and thoroughly examined the proposed sites for the Plaquemine Lock, the character of the approaches in the different cases, the nature of the soil upon which the locks would be built, etc.

On the 17th instant a full discussion of the different matters relating to the subject under consideration was had and the following conclusions reached:

1. That the nature of the soil does not present any insurmountable obstacles to the safe construction of the lock.

2. In consideration of the very great head of water under which the lock would have to be operated at times, it is deemed advisable to have two lock chambers instead of one.

3. The length of lock chamber as proposed by the local officer is deemed sufficient, but the width should be 55 feet instead of 52 feet as proposed by him.

4. The location proposed by Maj. Quinn is believed to be the most advantageous and desirable and is recommended for adoption for the following reasons:

But little excavation will be required for the body of the lock, and it can be carried on in a secure place and economically, since a great deal of it can be done by a floating dredge, the excavated material being deposited in the bed of the bayou between the lock and dike to advantage.

The large basin below the lock is desired by the parties interested in the navigation of the bayou as a place for the arrangement of boats and tows after passing the lock, and also as affording the most convenient landing place within the limits of the town. The bank between the lock and river will afford the necessary area for the storage of material and erection of work shops, and the materials for the lock can be landed from the river at this place and placed in the lock with the greatest convenience and least expense.

The bank between lock and river need not be disturbed until the lock is completed. It can then be excavated and the material cheaply disposed of behind the masonry of the lock and in the river. The encroachment of the river need not be greatly feared, for the bank protection works so far constructed appear to have been very successful.

The approach to the lock being much shorter than by any of the other proposed locations, it will therefore be easier to keep it in condition.

The area of land to be acquired is less than would be required in any other location, and the value of this land is no greater.

A blue print showing the location proposed is sent herewith.*

5. The preparation of detailed plans for the lock will be taken in hand as soon as practicable, and as soon as finished they will be forwarded with a final report.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
A. MACKENZIE,
Major, Corps of Engineers.
JAMES B. QUINN,
Major, Corps of Engineers.

*Not printed.

FINAL REPORT OF BOARD OF ENGINEERS ON LOCK AT MOUTH OF BAYOU PLAQUEMINE, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., January 7, 1892.

GENERAL: The Board of Engineer Officers constituted by Special Orders, No. 41, Headquarters, Corps of Engineers, U. S. Army, June 20, 1891, to consider the subject of a lock to connect the Mississippi River with Bayou Plaquemine, Louisiana, reassembled at New Orleans, La., December 22, 1891.

The Board first reviewed its action regarding the selection of a site for the lock which was reported in an indorsement dated July 17, 1891, and decided that there was no reason to depart from the selected site previously recommended. The location is shown on the map accompanying plans* for lock.

The Board then considered the plans and detailed drawings for a lock which had been prepared since the date of the preliminary report.

Since the only object of a double chamber, as previously recommended, was to divide the pressure of the water at extreme high water between two pairs of gates, instead of allowing this extreme pressure to be borne by a single pair of gates; and since it was advisable to have the lock as short as possible to the better accommodation of it to the location, as well as for economic reasons, it was decided to reduce the length of the first chamber to just sufficient to permit the swinging of the second pair of gates, and that a similar arrangement of gates be placed at the lower end of the lock, suitable arrangements to be made by means of openings in the lower gates of each pair and by by-pass valves to insure a proper level of water between them when the lock was in use, the main chamber to be of the dimensions previously reported. The general plan is shown in sheet No. 1.

The foundation was then considered. And the method of preparing the same, which has been successfully followed in the erection of similar constructions in the vicinity, was approved of.

This method will be readily understood by referring to sheets Nos. 2, 3, and 4.

It is in effect, to surround the site with sheet-piling, to then excavate the inclosed soil to a proper depth, to then compact the inclosed soil by driving piles of 25 or 30 foot lengths at distances apart of 3 feet from center to center, to then lay upon the heads of these piles a mass of concrete extending to the low-water level, as shown in the drawings, the foundation and the lock-walls to the level of low water forming a monolithic structure with a liberal bearing surface to support a massive superstructure.

Since there is some doubt as to concrete in large masses not submerged maintaining its integrity, brick laid in cement is recommended for the superstructure, *i. e.*, that part of the walls above low-water level. And since it is desirable to have this part as light as is consistent with proper stability and strength to avoid any possible overloading of the foundation soil, and for economic reasons also, the system of construction illustrated in the drawings is recommended, *i. e.*, with relieving arches.

It is recommended that the gates be of iron. The gates represented in the drawings, in sheets Nos. 5 and 6, are calculated to have sufficient strength to withstand the full head of water at high water. They

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* Map and drawings not printed.

are precisely alike, so that in case of accident one set could be substituted for a disabled set.

The manœuvring of the gates to be effected by means of a spar worked by hand, after the pattern in use upon the Keokuk locks, Mississippi River.

The cylindrical valves, of the pattern used upon the Muskingum River locks, is recommended for the filling and emptying valves, this pattern of valve having proved efficacious and economical. This valve is represented in detail upon sheet No. 8 and the method of installation upon sheets Nos. 4 and 7.

The same pattern of valve to be used for the by-pass valve at the upper gates, the installation of which is not shown, but is similar to that of the others, differing only in the level at which it is placed.

The mitre sills are of cut granite securely bolted to the concrete and to be provided with a suitable timber cushion piece.

Recesses are to be provided in the fore and tail bays for the reception of a timber dam in the event of its being necessary to empty the lock to make repairs, and within the body of the lock slight recesses to hold iron ladders to extend from the bottom to the top of wall.

There is also to be two or more rows of mooring hooks in the face of the lock walls, and snubbing posts upon the tops, also four hand capstans upon the top of the walls for manœuvring craft when using the lock. While these minor details are not shown in the drawings their cost has been included in the estimates.

ESTIMATED COST.

Excavation, 220,000 cubic yards, at 20 cents	$44,000.00
Piles, 8,180, at $5	40,900.00
Sheet piling, 325,080 feet B. M., at $25 per M	8,127.00
Granite for miter sills, 4,959 cubic feet, at $1	4,959.00
Timber for buffers, etc., 9,360 feet B. M., at $20	187.20
Wire rope for spar, 400 feet, at 16 cents	64.00
Concrete, 33,021 cubic yards, at $8	264,168.00
Bricks, 11,477 M, at $20	229,540.00
Wrought iron, 667,352 pounds, at 7 cents	46,714.64
Cast iron, 182,040 pounds, at 5 cents	9,102.00
Steel, 12,592 pounds, at 9 cents	1,133.28
Ladders, capstans, and moorings, etc	5,104.88
Cylindrical valves	6,000.00
Purchase of site	40,000.00
Total	700,000.00

Working contingencies are included in the several estimates.

Respectfully submitted,

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

BALTIMORE, MD., *January 12, 1892.*

A. MACKENZIE,
Major, Corps of Engineers.

ROCK ISLAND, ILL., *January 9, 1892.*

JAMES B. QUINN,
Major, Corps of Engineers.

NEW ORLEANS, LA., *January 7, 1892.*

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

S 7.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

During the high water in the Atchafalaya River a bar forms at the mouth of the Courtableau, but upon the subsidence of the Atchafalaya the reflex water of the bayou causes some scour to take place on the bar.

Acting upon the supposition that if all the water carried by the Courtableau was concentrated upon the bar obstructing its mouth it would be removed, a project was approved in 1879 which had for its object the closing of all bayous flowing out of the Courtableau to the southward to prevent any escape of water by these lateral streams, and to construct locks and dams so as to make slackwater navigation; first, Port Barre, 17 miles up stream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the annual report of 1886 that the cost of masonry, lock, and dam would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous, and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar. The result was favorable, and 3 feet increased depth of water was obtained in two days.

It was reported that the swampers cut one of these dams afterwards and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise caused one of these dams to break, but it was repaired, and during the following summer good results were hoped from the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

From the report of Lieut. Crosby (Annual Report, Chief of Engineers, for 1887, page 1376), who made an examination of this stream in September, 1886, it will be seen that the prospects of success, even with all the runout bayous closed, are anything but certain, yet the closing of two of the principal outlets in one season did produce an increase of 3 feet depth of water. In view of this fact, and that the project called for the closing of these bayous, work was resumed in October, 1886, with the money appropriated in August of that year.

Slight repairs were made to the old dams in the Big and Little Fordoche, and a new dam was built in Bayou English. Bayou Mamzelle was similarly closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased, in December, the bar was cutting out rapidly, there being then a channel of from 3 to 5 feet deep, while when work began there was one of but a few inches in depth. The new channel was then of no use, however, as the closure of Old River permitted no boats to enter the Atchafalaya from the Mississippi River.

The high water of 1888 formed the bar again, as usual, depositing sand to a depth of probably 6 or 8 feet over a length of 2 miles.

From a personal examination made in October, 1888, by Capt. Fisk, during low water, it was observed that the preceding high water had cut around one end of each of the dams already built, but they had caused a sand bar to form at each, varying in height from 2 to 3 or 4 feet above the water in the Courtableau at the time of the examination,

thus forcing all the water in the bayou to pass out into the Atchafalaya across Little Devil Bar, the head of which was then some 300 or 400 yards above the Little Fordoche. The volume of water, considerably greater than usual at low water, due to heavy local rains, was running with great velocity, and was moving a large quantity of sand, as could be plainly seen, but the depth at the shoalest point could not have been greater than 18 inches.

Had the bar been cut out to a suitable depth for navigation it is doubtful if it would have left sufficient water in the bayou above for purposes of navigation.

As soon as possible preparations were begun after high water in 1888 to repair the existing dams and to build others, and for closing some of the remaining outlets, but before the plant which was to be used on the work could be put in repair the water rose to such a height that nothing could be done.

The water having fallen sufficiently, work was resumed on September 2, 1889. The broken dams in Bayous Mamzelle, English, and Fordoche were all repaired and left in good condition. Bayous Big Cane and Little Cane, both of which are small and of little importance, were obstructed by clashing trees into them and the boats taken to Bayou Juramon on November 23 for work, but the water rose so rapidly the plant and lumber had to be taken to Washington, laid up, and the crew discharged November 30, 1889.

Nothing was done during the fall of 1890 beyond slight repairs to the derrick boat, and, owing to high water, work was not resumed until September of the following year.

The dams at Bayous Cane, Mamzelle, and Big Fordoche were all repaired with piles and sheet piles, brush aprons placed above and below them, held down by sinking trees and earth, and left in good order. The work was discontinued November 20 and the plant laid up at Washington, La.

Through the influence of the dams constructed, the bar has washed out so as to give a navigable depth at a stage of water in the Atchafalaya 7 feet below the level at which navigation was interrupted in the summer of 1891, but it is doubtful if the completion of the present project will permanently remove the bar at the mouth, as Little Devil Bar will reform at each high water of the Atchafalaya River.

The dams are in fairly good condition, but will require extensive repairs in another year, particularly the older ones.

The sum of $30,781.70 has been expended on the improvement of the Bayou Courtableau to June 30, 1892.

For continuing the improvement by constructing dams and repairs to those already built, the sum of $3,500 can be economically expended during the ensuing year.

Abstract of appropriations for improving Bayou Courtableau, Louisiana.

By act of Congress approved—	
June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
August 5, 1886	5,000
By act of Congress—	
Passed August 11, 1888	5,000
Approved September 19, 1890	2,200
Total	31,200

Money statement.

July 1, 1891, balance unexpended	$2,825.13
June 30, 1892, amount expended during fiscal year	2,406.83
July 1, 1892, balance unexpended	418.30
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	3,500.00

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Number of steamers	6
Registered tonnage	1,614
Number of trips made	69
Aggregate tonnage	24,370
Number of barges	18
Aggregate tonnage of same	8,900

Draft of largest steamer, light, 3 feet; loaded, 8¼ feet.

There were no new lines of transportation established during the year just closed.

Receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Sugar	1,584	$128,040	658	$52,897
Molasses	427	10,950	314	14,260
Rice	1,390	13,756	600	22,500
Cotton and seed	13,460	2,160,135	11,717	564,149
Hides	21	1,600	8	869
Staves	412	2,152		
Wood	2,909	6,646		
Miscellaneous freight	88	17,970	64	8,806
Total	20,291	2,341,339	13,361	662,981
Receipts.				
Estimated at	12,327	1,576,005	6,680	331,490
Total	32,618	3,917,344	20,041	994,471

Comparative statement of receipts and shipments for three years.

Year ending May 31—	Tons.	Value.
1890	35,967	$4,629,584
1891	32,618	3,917,344
1892	20,041	994,471

The above is the combined traffic of Bayous Courtableau and Des Glaizes, which can not be accurately separated, but probably about one-half belongs to each. The depreciation in tonnage and values is due to floods and crevasses.

S 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

Ordinarily, this bayou is navigable for steamboats throughout the year.

Prior to 1886 logs, snags, and impending trees obstructed the channel, but money having been appropriated the stream was thoroughly cleared of such obstructions from Port Barre down.

In 1890 Congress appropriated $5,000 with which to remove the obstructions that had found their way into the bayou since 1886.

Operations were commenced at St. Martinsville in October, 1891, with hired plant, and the improvement extended to a point about 59 miles below. Work was discontinued December 10, 1891. The main obstructions removed from the channel as the result of the year's work were 238 snags, 144 piles, 98 overhanging limbs, 36 overhanging trees, 30 fallen trees, 50 sunken logs, 18 floating logs, and 37 stumps.

There has been expended on the improvement of this bayou to June 30, 1892, the sum of $54,349.16.

Abstract of appropriations for improving Bayou Teche, Louisiana.

By act of Congress approved—	
July 11, 1870	$17,500
June 14, 1880	6,000
March 3, 1881	20,000
July 5, 1884	6,500
September 19, 1890	5,000
Total	55,000

The improvement of the Teche can not be considered as permanent, since sunken logs, fallen trees, and wrecks of coal boats are constantly forming obstructions which will require removal. The sum of $5,000 will be required for this needed improvement during the ensuing year.

Money statement.

July 1, 1891, balance unexpended	$5,421.84
June 30, 1892, amount expended during fiscal year	4,771.00
July 1, 1892, balance unexpended	650.84
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Number of steamers	4
Registered tonnage	1,362
Number of trips made	36
Aggregate tonnage of same	13,297
Barges entering the bayou with coal	85
Aggregate tonnage of same	53,370

Draft of largest steamer, light, $2\frac{1}{4}$ feet; loaded, 8 feet.

No new lines of transportation have been established during the year.

Comparative statement of receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Sugar	7,675	$607,938	2,397	$230,334
Molasses	4,010	121,790	1,406	41,181
Rice	78	3,362	184	7,143
Potatoes and onions	85	3,571	20	396
Eggs	20	4,657	3	976
Moss	40	2,005	39	1,950
Pecans	5	630	1	195
Hides	100	10,014	9	864
Cotton and seed	742	79,814	515	54,951
Cotton-seed oil	181	11,360	204	12,474
Wood	2,374	6,785	2,359	6,066
Miscellaneous freight	60	3,000	48	4,795
Total	15,370	855,026	7,185	361,325
Receipts.				
Machinery, coal, etc	11,535	860,000	57,681	471,785
Grand total	26,905	1,715,026	64,866	833,110

The decrease in totals of the principal products is attributed mainly to the fact that, owing to the interruption of navigation through Old River, and at a time when crops were being marketed, no steamboat could get to the Bayou Teche until about six weeks later than during the previous year.

S 9.

IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

In 1874, and again in 1882–'83, cuts were made through the bars in Calcasieu Lake, above Calcasieu Pass. The dredged channel was 8 feet deep, 70 feet wide, and 7,500 feet long. The work was done under contract.

The channel had again shoaled in 1885 to a depth of 3½ feet and needed redredging, but, by an unfortunate wording of the appropriation, funds in hand for "improving Calcasieu River" could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and the river.

Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 130 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet wide and 6 feet deep, the material excavated to be thrown outside the revetment walls.

The same contract also provided for the excavation of a channel through the bar at the mouth of the Calcasieu River, at the northern end of the lake, 100 feet wide and 6 feet deep. Work was commenced on the revetments in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness due to exposure on this work.

In the spring of 1887 work was resumed by the administrator of the contractor's estate, and the revetment nearly completed. At the date of the annual report for 1887 a dredge was expected to begin work

within a few weeks, and actually arrived there about the middle of August, but was not ready for work until the last of November on account of the repairs necessary and the delay in making them.

About the middle of September, when it was thought the dredge would be ready for work in a few days at the very latest, the administrator began driving down the planking of the revetment into the ditch the water had dug under it, but after one day's work stopped. No work was done by him after that time, and the contract was annulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do the work by hired labor and open market purchase, using the Government dredge, which had shortly before finished the improvement of Bayou Terrebonne. A careful examination developed the fact that the revetment was so badly worm eaten as to be worthless, showing that the life of timber there was short. Application was made to so far modify the project as to omit the revetment, and this modification was approved by the Chief of Engineers January 12, 1888. The dredge was put in good condition and began work on the 19th of March.

Two deck barges were hired and arranged for use as dump scows, but two days' work with them showed that the wooden shafts or Spanish windlasses used for closing the dumping doors were not strong enough. These were replaced with 3-inch iron shafting and worked well. The material taken out by the dredge amounted to 77,159 cubic yards, completing the work as projected August 31, 1888.

In 1888 $10,000 was appropriated for continuing this work, but as the former work did not prove to be permanent and the amount was too small to begin operations with it was held subject to future consideration.

As projected the work was not permanent, and at present the dredged channels have almost entirely disappeared. In order that the produce of the country bordering the Calcasieu River may find a safe water route to the Gulf, it is essential that the bars at the head and foot of Calcasieu Lake, or what is known as the passes of Calcasieu River, have channels through them of about 8 feet in depth, and if it is proposed to continue this improvement the channel should be revetted to insure permanency.

In 1890 Congress appropriated $75,000 for "improving the mouth and passes of Calcasieu River" according to the plan reported by Maj. W. H. Heuer, Corps of Engineers, in 1886, and confirmed by Capt. W. L. Fisk, Corps of Engineers, in his report of November, 1888.

As this project was for the improvement of the mouth of the Calcasieu River by means of jetties, etc., which must be built in a very much exposed location in the gulf, the amount of money available was considered to be entirely too small with which to commence operations, economically, and was accordingly held for future increase.

Abstract of appropriations for improving mouth and passes of Calcasieu River, Louisiana.

By act of Congress approved—	
June 10, 1872	$15,000
March 3, 1881	15,000
By act of Congress—	
Passed August 2, 1882	10,000
Approved July 5, 1884	6,500
Passed August 11, 1888	10,000
Approved September 19, 1890	75,000
Total	131,500

Money statement.

July 1, 1891, balance unexpended	$84,935.40
July 1, 1892, balance unexpended	84,935.40
Amount appropriated by act approved July 13, 1892	100,000.00
Amount available for fiscal year ending June 30, 1893	184,935.40
Amount (estimated) required for completion of existing project	425,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	350,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statistics for the calendar year 1891 were furnished by the Lake Charles board of trade. This is the best information I have been able to obtain of the commerce of this river.

Number of vessels	32
Total registered tonnage	1,500
Aggregate number of trips out of river	300
Aggregate tonnage of same	450,000

Average draft of vessels, light, 2½ feet; loaded, 5½ feet.

The output of the mills on the river last year were:

Articles.	Tons.	Value.
Lumber	217,000	$1,327,500
Shingles	7,200	108,000
Total	224,200	1,735,500

The number of acres in cultivation tributary to the Calcasieu River are:

Rice	37,434
Corn	6,523
Sugar cane	564
Fruit	1,747
Cotton	5,200

The mercantile transactions of Lake Charles and vicinity for 1891 amounted to $3,841,210.

S 10.

IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

The object of the improvement is to obtain a deep-water channel through the bar into the harbor. Originally the bar had but 6 feet of water upon it.

In 1878 and 1880 channels from 12 to 16 feet were dredged through the bar, but as no protection for the cuts thus made was provided they soon filled up. In 1882 a project was adopted for improving this harbor by means of two jetties of brush and stone, aided by dredging, if necessary, at a total estimated cost of $3,177,606.50.

Since the approval of this project appropriations amounting to $1,098,750 have been made, of which sum $300,000 became available by the river and harbor act of September 19, 1890. All the work done under these appropriations has been by contract.

It is proper to remark that the appropriations have come at intervals of two years, and that in eight years about one-third of the estimated cost of the improvement has been appropriated. Instead of the improvement being completed as it should have been to obtain the best results both commercially and in an engineering point of view, it is but about one-third completed, and the situation would be disheartening were it not for the fact that the results have been more favorable than was to be expected.

CONDITION OF THE WORK.

The present total length of the east jetty built is 17,100 feet (3¼ miles), of which the outer 450 feet consists of foundation work only, to prevent scour around the end. The total length of the west jetty built is 9,500 feet, its outer extremity being abreast of 13,000 feet on the east jetty.

The 2,500 feet of the outer end of this jetty was only built to within 5 to 8 feet of the surface of the water, or, properly speaking, is foundation work only.

An experimental section 240 feet long was constructed at the outer end of the east jetty. The foundation of this section is 112 feet wide, and the riprapping consists of rubblestone faced with blocks of stone weighing from 1 to 3 tons. Its crest was, at the close of work, about 4½ feet above mean low water.

In December, 1889, a survey of the pass was made and the results are given in the Annual Report of 1890 of Capt. Fisk, Corps of Engineers.

February 10, 1891, a Board of Engineer Officers was convened at Sabine Pass to consider the subject of further improvements.

The Board made an inspection of the jetties, and in their report to the Chief of Engineers recommended that the jetties which had settled some since being built, and also suffered some loss in height from wave action and other causes should, in order to concentrate the scouring effect of the ebb current upon the bar, be covered with large stone, the crest of this covering to be placed 2 feet above the level of high water; also that the west jetty be extended as far as the funds available would permit.

The recommendations of the Board having been approved, advertisements were issued inviting proposals for doing the work, and on the 11th of April the bids received were opened and Messrs. Charles Clarke & Co., of Galveston, Tex., were found to be the lowest bidders. A contract was entered into with them and it was duly approved May 27, 1891. The contractors commenced work August 6, following.

The work did not progress satisfactorily at the start owing to a good many unforeseen difficulties, and in consequence the contract can not be completed on the agreed date, July 15, 1892, and the time for completion has been extended.

The east jetty has been raised to 2 feet above mean high water from a point 1,025 feet from its inner end to a point 2,190 feet from its outer end.

The west jetty has been raised to 2 feet above mean high water from a point 1,457 feet from its inner end to a point 4,083 feet from this end.

About 1,500 feet of this jetty beyond the finished portion has been raised until the crest is an average of 1½ feet below mean low water.

The material between the jetties and upon which the jetties are founded is a stiff mud, with patches and layers of rather firm, blue clay, and in consequence the scour due to the unaided current is not rapid nor is the subsidence of the rock jetties as great as the superficial indications would fully warrant.

When the rock was first put on the jetties a settlement of about 2 feet occurred, due to actual subsidence and the compacting of the riprap, but after this the subsidence did not exceed .4 of a foot in two months at any place, and in over half of the stations observed there was no subsidence.

As the jetties were not up to full height at the end of the year, and particularly at the inner ends where wide intervals intervened between the completed portions and the shore through which a considerable volume of water escaped, no attempt at disturbing the bottom between the jetties so as to assist the scouring effect of the current was attempted. In consequence but little improvement, if any, in the depth of the water between the jetties was expected. The examination just completed shows there has nevertheless been a very considerable improvement over the entire area between the jetties, and that the 12-foot curve of depth on the inside has advanced seawards 3,800 feet and the outside 12-foot contour has moved in 200 feet.

The material carried out by the current has disappeared completely, for no shoaling has taken place beyond the ends of the jetties, and it is reasonable to suppose that had the material between the jetties been stirred up so that the current could have acted upon it to advantage the increase in depth would have been considerably greater notwithstanding the incomplete state of the work.

Arrangements have been made with the present contractors to stir up the mud in the channel during ebb tide as soon as the work is a little further advanced.

The contractors were not able to obtain all the rock required from the quarries in the vicinity as a great portion of the native rock was under weight, and they therefore made arrangements to receive large quantities from New York.

To favor the native product and also to advance the work, a concession in the matter of required weight of a certain portion of the rock to be supplied was made, the lighter rock being, however, supplied at a reduced cost per ton.

This supplementary agreement was approved April 5, 1892, and under it the contractors are to furnish not to exceed 5,000 tons of large rock for capping, at $4.50 per ton of 2,240 pounds, and 3,000 tons of riprap at $3.20 per ton, none of the rock to weigh less than 130 pounds to the cubic foot. This rock is to be used upon the inner ends of the jetties and where it will not be exposed to violent wave action.

The accompanying chart gives the result of the examination made between May 2 and June 29, 1892. It will be observed that there is full 10 feet depth throughout the pass at mean low water. As the bottom is very soft it is proper to state that this does not indicate precisely the navigable depth since a vessel drawing 14.1 feet entered the pass safely.

The total amount expended on this work to June 30, 1892, was $1,319,848.48.

Abstract of appropriations for improving harbor at Sabine Pass, Tex.

From act approved August 30, 1852 (survey)	$5,000
Allotted from act of Congress approved June 10, 1872 (for survey)	2,000
By act of Congress approved—	
March 3, 1875	20,000
August 14, 1876	38,000
June 18, 1878 (allotted)	30,000
March 3, 1879	25,000
June 14, 1880	50,000
March 3, 1881	150,000
By act of Congress passed August 2, 1882	150,000
By act of Congress approved—	
July 5, 1884	200,000
August 5, 1886	198,750
By act of Congress passed August 11, 1888	250,000
By act of Congress approved September 19, 1890	300,000
Total	1,418,750

Money statement.

July 1, 1891, balance unexpended		$298,327.56
June 30, 1892, amount expended during fiscal year		199,426.04
July 1, 1892, balance unexpended		98,901.52
July 1, 1892, outstanding liabilities	$43,847.59	
July 1, 1892, amount covered by uncompleted contracts	39,009.97	
		82,857.56
July 1, 1892, balance available		16,043.96
Amount appropriated by act approved July 13, 1892		350,000.00
Amount available for fiscal year ending June 30, 1893		366,043.96
Amount (estimated) required for completion of existing project		1,728,856.50
Amount that can be profitably expended in fiscal year ending June 30, 1894		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

[From June 1, 1891, to May 31, 1892.]

Vessels entering		27
Vessels clearing		25
Total		52
Average tonnage of same		38,764
Average draft of vessels entering and clearing	feet	9.77
Deepest draft entering	do	14.1

No new lines of transportation were established during the year.

Receipts and shipments for two years.

Articles.	Year ending May 31, 1891.		Year ending May 31, 1892.	
	Tons.	Value.	Tons.	Value.
Shipments.				
Cotton	50	$10,000	20	$3,200
Cotton seed	180	2,000		
Hides	12	1,200	10	1,000
Alligator skins	80	6,000		
Shingles	480	3,600		
Lumber	3,332	19,392	23,951	179,632
Total	4,084	42,792	23,981	183,832
Receipts.				
Rock			14,047	42,131
Total	4,084	42,792	38,028	225,963
Increase over previous year			33,944	183,171

The shipments of lumber from Orange, Tex., during the year amounted to 159,142 tons, valued at $1,208,495.

S 11.

IMPROVEMENT OF SABINE RIVER, TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872–'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year.

The estimated cost of improvement over this stretch of river by the removal of obstructions, such as logs, snags, fallen trees, etc., was $18,000.

Congress appropriated $10,000 in 1878 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth.

In 1879 Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton.

After the survey was completed it was deemed advisable to spend this money in improving the river above Orange, and cuts were made from the main river into the Narrows and at Dead Bend.

Large numbers of sunken logs and snags were removed from the upper part of the Narrows, enabling vessels of 5 feet draft to get 30 miles above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more, for this river. The bar at the mouth had again shoaled. This was redredged in 1881–'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length, which still remains in fair condition.

In 1882 Congress appropriated $4,000 more for this improvement. As the river was in a sufficiently good condition for the limited commerce which it carried, this money was held for further use.

An examination in May, 1889, showed many snags and some shoal

places in the part of the channel known as the Narrows, and as some $4,000 was available for work, a project was submitted for removing the snags and closing the two "Old River" branches with dams of piles, brush, and earth, to throw all the water into the Narrows.

This project was approved, the work advertised, and contract was entered into September 20, 1889, with the Sabine Tram Company to complete the work by December 1, 1889, for $3,647.

The smaller dam was successfully built, and most of the piles driven for the larger one, when a sudden rise in the river washed out many of them. The water continued rising, and remained so high that satisfactory work could not be done, so the contract was extended to October 30, 1890, by the Chief of Engineers. Work was resumed in September, 1890, and finished in December of that year, completing the project.

There has been expended $34,613.12 on this stream to June 30, 1892.

The river from its mouth to Sudduths Bluff requires improving by the removal of snags and other obstructions. For this work $10,000 can be profitably expended during the next year.

It is estimated that about $2,000 will be required annually to keep the river in condition after the snags are removed.

About 8,000 tons of produce were shipped down the river last year, consisting of corn, rice, cotton, cotton seed, etc., besides a great many logs for the mills at Orange, where they are manufactured into lumber.

Abstract of appropriations for improving Sabine River, Texas.

Allotted from act approved June 10, 1872	$2,700
By act of Congress approved—	
June 18, 1878	10,000
March 3, 1879	6,000
June 14, 1880	5,000
March 3, 1881	7,000
By act of Congress passed August 2, 1882	4,000
Total	34,700

Money statement.

July 1, 1891, balance unexpended	$86.88
July 1, 1892, balance unexpended	86.88
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,086.88
Amount that can be profitably expended in fiscal year ending June 30, 1894 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

S 12.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873, and resurveyed from Bevilport to its mouth.

The project for improvement contemplated the dredging of a channel over the bar at the mouth and the removal of obstructions from the river between Bevilport and Yellow Bluff.

In 1880 the bar at the mouth was dredged, and a channel 5 feet deep and 30 to 60 feet wide was obtained. The obstructions in the river between Yellow Bluff and Bevilport were removed in 1882.

The original estimate of the cost of the improvement was, for work at the mouth of the river $26,318.05, and for up river $15,000; a total of $41,318.05.

The bar at the mouth of the river again shoaled, until at extreme low water there was a depth of about 3 feet over it.

There is very little commerce passing in and out of the river, but as the bar at this place was the shoalest obstruction between the Gulf and Beaumont, Tex., and the money was available for dredging the bar, it was thought advisable to reopen this channel.

The Government dredge, which had completed work at the head of the Calcasieu Pass, was placed in good repair and sent over to the mouth of the river in December, 1888, for the purpose of redredging the channel over the bar. By the first of May following the dredge had removed 55,482 cubic yards of material and completed a 5-foot channel on the line of the old one, of which traces still remained.

The total amount thus far expended upon the improvement of this river is $28,842.16, leaving still unexpended $4,157.84.

The dredged channel can not be expected to be permanent in such a broad and shallow body of water as Sabine Pass, but will probably serve all the necessities of the commerce using it for several years.

No appropriation is asked for the next fiscal year.

Abstract of appropriations for improving Neches River, Texas.

By act of Congress approved—	
June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
By act of Congress passed August 2, 1882	5,000
By act of Congress approved July 5, 1884	7,000
Total	33,000

Money statement.

July 1, 1891, balance unexpended	$4,157.84
July 1, 1892, balance unexpended	4,157.84

COMMERCIAL STATISTICS.

Estimated shipments for year ending May 31, 1892.

Article.	Tons.	Value.
Cotton	750	$150,000

The product of the logging interests is about 75,000,000 feet annually, and this will be increased considerably by hewn timbers, staves, etc., when the lumber export business is well established at Sabine Pass, Texas.

The river traffic has greatly decreased in the last ten years, owing to the railroads penetrating part or the tributary territory.

At one time between 20,000 and 30,000 bales of cotton were brought down the river annually; now there are not more than from 1,000 to 2,000 bales. The up-river freight has fallen off proportionately.

S 13.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

The British bark *Bruce* was condemned as unseaworthy, and sold at auction the latter part of 1890. In December of that year it sunk at anchor in the harbor of Ship Island, Mississippi, and formed an obstruction to the safe navigation of this harbor. It was abandoned by the owners, and authority to remove it was obtained from the War Department March 23, 1891.

Proposals for doing the work were invited by advertisement, and upon opening the bids, April 27, 1891, the Alabama Dredging and Jetty Company, of Mobile, Ala., were found to be the lowest bidders, their bid being $1,490.

They were awarded the contract, and commenced work on June 19, 1891, and reported the work completed August 1, 1891. An examination of the locality failed to find any remains of the wreck, and the contractors were paid in full.

As there was nothing of value remaining in the wreck it was blown up with dynamite, and owing to the inexperience of the contractors it is estimated that they suffered a loss of at least $1,000.

The total amount expended in the removal of this wreck was $1,764.83.

Sunken coal barge in Bayou Teche, Louisiana.—It was reported on March 5, 1892, that a coal barge had sunk in Bayou Teche, Louisiana, and formed an obstruction to the navigation of this bayou.

Authority for its removal was obtained March 28, 1892, but owing to the occurrence of high water nothing further has been done.

S 14.

PRELIMINARY EXAMINATION OF SABINE RIVER, TEXAS, FROM WHERE SAID RIVER EMPTIES IN SABINE LAKE TO SUDDUTHS BLUFF, ON SAID SABINE RIVER.

[Printed in House Ex. Doc. No. 20, Fifty-second Congress, first session.]

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 3, 1891.

GENERAL: I have the honor to submit the following report of a preliminary examination made by me on August 27, 1891, of Sabine River, Texas, "from where said river empties in Sabine Lake to Sudduths Bluff, on said Sabine River," provided for in the river and harbor act approved September 19, 1890.

Upon referring to the Chief of Engineers' Report for 1873, pages 680–684, it will be observed that a detailed survey of the Sabine River from Sabine Lake to Belzora, Tex., was made between October, 1872, and April, 1873. The report states that the condition of the river is such that an expenditure of $18,000 for its improvement from Hamilton down would be warranted. In 1879 a resurvey of this portion of the river was made, and the report appears in Chief of Engineers' Report for 1880, pages 1195–1200. In 1880 a contract for the improvement of the Narrows, a portion of the river about 18 miles long, was made, and work was commenced in 1881. Pages 1321–1322, Report of the Chief of Engineers for 1881.

This work was completed the following year, and in 1883 the officer

in charge reported: "The river now is in as good condition, so far as improvement is concerned, as it can be made, and is likely to remain so for several years." (Chief of Engineers' Report for 1883, page 1056.) No further improvement of the river was recorded until 1889 (Chief of Engineers' Report, 1889, page 1494), when it was recommended that the money available, $4,521.66, be expended in removing snags. A contract for the construction of brush dams in Old River, so as to throw all the water into the narrows, was made in 1889 and the work was completed in 1890.

As a result of this damming of Old River the amount of water diverted into the narrows has caused a good deal of caving in of the banks, and the trees thrown into the river in this way have caused a great many snags, which obstruct the channel.

A good many saw logs on the way to the mills at Orange, Tex., are caught by these snags and add to the difficulties of navigation. These snags lie mostly in the deep-water bends and force the steamboats over to the shoal water on the opposite shore. Their removal would consequently give a deeper channel for the use of steamboats than can be had at present.

Below Sudduths Bluff there is another place which requires cleaning out some, and several trees on the banks should be removed.

Below Orange to the lake no improvement is needed, as the river is deep.

Since the principal difficulty at present which navigation has to encounter in the river between Sabine Lake and Sudduths Bluff is shoal water, caused by the snags, etc., which obstruct the channel, I do not think any detailed survey is required. The removal of the snags between the points named will cost $10,000.

About 8,000 tons of freight came down the river last year, and it is expected that nearly as much more will be shipped this way the present year, as more boats will be in this trade.

The products shipped by water are cotton, corn, rice, cotton seed, and general merchandise, and an immense amount of logs for the mills at Orange, where they are manufactured into lumber. The annual output of the mills is about 120,000,000 feet of lumber, 30,000,000 shingles, and 10,000,000 laths and pickets.

The removal of the snags will meet the requirements of the river commerce for the present, but it is not expected that this improvement will be permanent. It will require $2,000 a year to keep the river in condition after the snags are removed.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[Third indorsement.]

OFFICE U. S. ENGINEER,
New Orleans, La., September 24, 1891.

Respectfully returned to the Chief of Engineers, U. S. A.

In addition to the within, I have the honor to state that, in my opinion, the locality is worthy of improvement.

JAMES B. QUINN,
Major, Corps of Engineers.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, September 29, 1891.

Respectfully returned to the Chief of Engineers.

In my opinion the river is worthy of improvement by the removal of bad snags.

C. B. COMSTOCK,
Col. of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

APPENDIX T.

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING, AND REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION OF NEW ORLEANS HARBOR, LOUISIANA.

REPORT OF FIRST LIEUTENANT JOHN MILLIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

IMPROVEMENTS.

1. Securing mouth of Bayou Plaquemine, Louisiana, from further caving.
2. Removing sunken vessels or craft obstructing or endangering navigation in the Mississippi River below New Orleans, Louisiana.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 30, 1892.

GENERAL: I have the honor to submit the following report upon the works in charge of this office under the Chief of Engineers, U. S. Army, for the year ending June 30, 1892:

* * * * * * *

Very respectfully, your obedient servant,

JOHN MILLIS,
First Lieutenant of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

T 1.

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

This bayou was formerly a diffluent or outflowing branch of the Mississippi River. It left the river at the town of Plaquemine, La., and after a course of about 10 miles began to branch off or divide into an intricate network of bayous, the whole system connecting with the Atchafalaya and Grand rivers and with Grand Lake.

While the bayou remained connected with the Mississippi it was leveed on both sides for some distance down. In 1865 the levee system on the west bank of the Mississippi was carried directly across the head of the bayou, cutting it off from all communication with the Mississippi and terminating its functions as an outlet. The bayou being deprived

of a direct supply of water from the Mississippi, now depends on back water from Grand Lake and the connecting rivers and bayous, and in low water it becomes very shoal or nearly dry.

By the river and harbor act of August 11, 1888, an appropriation was made for securing a navigable channel in this bayou up to the dike at Plaquemine and for preventing further caving of the bank of the Mississippi at the "mouth" (head) of the bayou.

The deepening of the bayou by dredging and the construction of a system of locks to afford navigable entrance to the bayou from the Mississippi are in contemplation. The work of bank protection was placed in charge of this office by letter of May 15, 1889, from the Chief of Engineers, U. S. Army.

The plant belonging to the general works of improvement in the Fourth District, Mississippi River, of which this office also has charge, is thus rendered available for the Plaquemine work at such time as it is not required elsewhere.

The sum of $75,000, from the amount appropriated by the act of August 11, 1888, for the improvement of the bayou, was allotted for bank protection at the head.

The approved project under which this sum was to be expended contemplated the building of four large submerged spur dikes with sloping crests running out at right angles to the shore. These dikes were to be built of willow brush, timber, and stone, in accordance with the general method of construction adopted by the Mississippi River Commission for that class of work in this part of the river, the shore end of each spur to extend up to low water, and from that point a spur levee built of earth was to run to the main levee. The portion of this levee below high-water line was to be covered with a layer of gravel and then a layer of stone. Four of the dikes were to be built with the funds available; two above the bayou and two below, at intervals of about 900 feet.

The two dikes above the bayou, Nos. 1 and 2, were built in 1889-'90.

The sum of $60,000 for continuing the work was allotted from the amount appropriated for the general improvement of the bayou by the act of September 19, 1890, but the lateness of the season when the appropriation became available rendered it impracticable to resume work before the following year.

At the date of the last annual report rock for continuing the work had been procured from the Government quarries near Harrisonburg, La., and stored on the bank.

The earthen spur levees of the completed dikes, Nos. 1 and 2, had been somewhat injured by the flood of 1890 which followed soon after their completion, and the top crib of Dike No. 1 had been partly displaced. Otherwise the work seemed to be in good condition and the caving in the vicinity had almost entirely ceased.

The project approved for continuing the work under the additional allotment and in accordance with the general plan already adopted contemplated the extension of the work downstream and repairs to Dike No. 1. The plan of the dikes was modified, making the side slopes somewhat less steep than in those first constructed and omitting the spur levee extension at the head of the dike.

The willows for the season's work were cut by hired labor at Profit Island and near Port Hudson, La. The lumber was obtained principally at the local mills at Plaquemine.

Work commenced on September 28, and was finished on December 29, 1891, but there were several interruptions caused by portions of the

plant being required elsewhere to keep the other works of the district in progress.

Dikes 3, 4, and 5 were completed. Dike No. 1 was repaired by sinking a flexible mattress 400 feet long by 120 feet wide over its upper half, the downstream edge of the mattress coinciding with the center line of the dike. This mattress was fastened entirely with wire in order to give it greater flexibility, since the ordinary wooden fastenings are liable to be broken when the mattress is sunk on an uneven surface.

The completed protection work now extends to a distance of about 1,500 feet below the proposed entrance to the locks and 2,500 feet above. There has been extensive caving of the bank both above and below the work during the past season, but that portion of the bank covered by the dikes has remained intact.

About 5,000 tons of rock has been quarried near the mouth of Bœuf River and stored on the bank for continuing the work. There was left on hand at the close of last season's work 3,465 tons, making about 8,465 tons now on hand.

The work should be continued during the coming season by construction of additional dikes, either above, below, or between those already built, as may be found most needed to arrest the caving that may be developed after the present flood.

A portion of the appropriation for the general improvement of the bayou should be reserved for this work until the locks are completed and the bank rendered thoroughly secure.

A map accompanies this report showing the location of the completed work.

NOTE.—The money statement for this work is consolidated with that for the improvement of Bayou Plaquemine, Louisiana, Appendix S 6.

The field work during the year has been under the immediate charge of Assistant Engineer W. G. Price, who reports as follows:

REPORT OF MR. W. G. PRICE, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *February 3, 1892.*

SIR: I have the honor to submit the following report of submerged spur construction at Plaquemine, La., during the year 1891.

The rock for the work was taken last spring from quarries near Rawsons Creek, which is a tributary of the Ouachita River, and it was brought down during the high water and stored high up on the sloping bank near Plaquemine. The willows were obtained from Profits Island and vicinity during the progress of the work. As no plant has been constructed for this work, that belonging to the Red and Atchafalaya work was used, and as the barges were being repaired at Simmesport during the summer, no work was begun till the repairs were finished and the plant had been removed to Plaquemine.

The plant arrived at Plaquemine September 22, and the construction of mats was begun on the 28th.

No labor was subsisted except that necessary for the supervision and care of plant.

The cribs and mats for spurs Nos. 3 and 4 were completed October 30, and all labor except what was necessary to care for the plant was discharged.

On November 21 the construction of mats and cribs for Spur No. 5 was begun.

The work of sinking the spurs was begun December 1, and Spurs Nos. 3, 4, and 5 were completed on December 19.

The mats and cribs were constructed in the same way as those built here two years ago, and described in the report for the year 1890 (page 1761), except that all the mats were 120 by 400 feet and the cribs were wider at the bottom, so as to make the side slopes 1 on 2, which gives the crib work more strength to resist overturning.

The center line of the cribs in each spur was located 16 feet upstream from the center line of the mattress. An extra heavy weight of rock was placed in and on top of Spur No. 4, as the crib work is higher than the others and is exposed to a much swifter current.

The river bank at each spur was graded 120 feet wide and from its crest down to the edge of the mattress, and was covered 12 inches thick with rock. No spur levees were constructed.

Spurs Nos. 1 and 2 were built two years ago. No. 2 was found to be in good condition but Spur No. 1 had been injured by the inshore half of the top crib slipping off of those under it and was partly turned over on its side.

The spur was sunk with a large amount of drift under the cribs and mattress, and as it appeared to be somewhat uneven, you ordered me to cover it with a flexible mattress, 120 feet wide, 400 feet long, and 2 feet thick; which was constructed of willow brush and poles held together with wire rope, no wooden fastenings being used. It was constructed as follows: Willow poles spliced together to make 70 feet in length were laid down on the mat ways 10 feet apart. On these poles a thin layer of large willow brush was laid which crossed the poles and was thoroughly spiked to them. Then a thin layer of willow brush was laid on crossing the first layer, and then another thin layer was put on, which crossed the second layer, and then poles were placed on top same as those on the bottom, the top poles being directly over the bottom poles and parallel to them, the whole making a mattress 2 feet thick. On each bottom pole before the willows were laid on wire ropes were fastened at points 5 feet apart, as follows: A piece of No. 10 galvanized wire 25 feet long was doubled and twisted into a rope of two strands of 12 feet long. The center of the rope was placed under the pole and the two ends were brought up and twisted together, thus making a rope of four strands 5¼ feet long, which inclosed the pole tightly at one end and which was stiff enough to stand upright. After the top poles were put on the wire ropes were untwisted into two strands, drawn into the mattress and one strand was brought up on each side of the top poles. The mat was compressed by taking every third wire rope to a mat jack which pulled up the wire and pressed down the pole with any desired force, and then one wire rope on each side of the jack was hauled taut by hand and fastened by passing each strand one and a half times around the pole and twisting the ends together. Then the jack was moved and the rope used with it was made fast the same as the others. Five sections of this mattress 70 by 120 feet and one section 50 by 120 feet were wired together to make the completed mattress. A head block of 3 by 6 inches yellow pine was built on the upstream edge to give the necessary stiffness and strength for sinking it. It was constructed in the same form as the head blocks on the crib mats sunk at the other spurs. In the construction and sinking of this mattress there were used 500 cords of willow brush and poles, 1,502 pounds of galvanized iron wire No. 10, and 475 tons of rock.

The mattress was sunk with the downstream 400 feet edge on the center line of the crib work of the spur and with the inshore edge at the low-water line.

This work was finished on December 29.

The plant was then put in order for removal to New Orleans, and was taken there by the steamer *General Newton* on January 4.

The work was very much delayed by the lack of barges to transport the willows and rock, as a number of the barges of this plant were necessarily in use on other works. With the whole plant and a sufficient supply of material on hand the work could have been done in less than one-half the time. These delays increased the cost of the work.

During the progress of this work I designed and constructed a mat jack for compressing mattresses and cribs which does better work than by the old method and saves much time and expense.

The cost of the work was as follows:

Supervision	$1,387.15
Construction	25,866.81
Care of plant	1,550.56
Repair of plant	265.15
New plant	806.42
Total cost of work	29,876.09

Cost of grading and paving river bank above edge of mattresses for the three new spurs	$3,855.60
Cost of submerged portion of spurs per cubic foot	.42

The amount of rock used, 3,610 tons. Amount of willows used, 3,120 cords.

At the close of the work there was left on hand available for construction:

Yellow-pine lumber	feet..	17,800
Willow brush	cords..	350
Galvanized iron wire	pounds..	1,000
Rock	tons..	3,465
Iron spikes	kegs..	22¼

Very respectfully, your obedient servant,

W. G. PRICE,
Assistant Engineer.

Lieut. JOHN MILLIS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

As navigable connection between the Mississippi and Bayou Plaquemine has not yet been reëstablished the commerce which the work of bank protection at the head of the bayou is designed to promote does not exist. The following statistics refer only to the Mississippi River commerce at Plaquemine.

A comparison is made of the commerce for the years 1891 and 1892:

	1891.	1892.
Number of steamboats in trade	50	53
Number of times arrived	453	428
Number of times departed	388	402
Number of barges	52	66
Total cargo received ... tons	61, 110	82, 214
Total value of same	$819, 176	$1, 023, 243
Total cargo shipped ... tons	57, 899	45, 234
Total value of same	$596, 899	$833, 479
Total cargo received and shipped ... tons	119, 009	127, 448
Total value of same	$1, 416, 075	$1, 856, 722

T 2.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION IN MISSISSIPPI RIVER BELOW NEW ORLEANS, LOUISIANA.

Complaint was received from pilots of the wreck of an old dry dock lying in the river off Point Celeste, about 42 miles below New Orleans. By direction of the Chief of Engineers, U. S. Army, an examination was made, and it was recommended that the wreck be destroyed by dynamite on hand, without extra expense. This recommendation having been approved, the wreck was blown up during the low-water season.

There is now a depth of 30 feet or more at low water over most of the wreck, and the least depth is 23 feet. The wreck is no longer an obstruction to navigation.

APPENDIX U.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

REPORT OF MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Cedar Bayou, Texas.
5. Buffalo Bayou, Texas.
6. Harbor at Brazos Santiago, Texas.

EXAMINATIONS AND SURVEY.

7. Brazos River, Texas, from its mouth to Waco.
8. West Galveston Bay, Texas, from Christmas Point.

UNITED STATES ENGINEER OFFICE,
Galveston, Texas, July 7, 1892.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1892.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The project for this improvement was adopted in 1874, and modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit of sea-going vessels of the deepest draft entering the harbor.

The projects of 1874 and 1881 contemplated construction of two jetties

to extend into the Gulf of Mexico to concentrate ebb flow upon the outer bar in the Gulf and also to effect deepening on the inner bar at the entrance to Galveston Channel. These jetties to have their origins, respectively, at Bolivar Point and Fort Point.

More or less work was done under those projects. Under that of 1881 a jetty was built from Fort Point to the crest of the outer bar, but it was not fully completed.

The project of 1886 (that now in progress of execution) also consists in construction of jetties to extend into the Gulf, one, the south jetty, starting from the east end of Galveston Island, and the other, the north jetty, to start from Bolivar Point, opposite. Or, to be more exact, the south jetty was to start from Fort Point, but in 1888 it was decided to connect the inner end of that jetty with the relatively high ground upon which the city of Galveston is built by a stone dike known as the shore branch.

The jetties are to be of rock, to be built to an elevation of 5 feet above mean low tide, and to extend, if necessary, to the contour of 30-foot depth in the Gulf, their sea ends to be 7,000 feet apart, the action of the jetties to be supplemented, if need be, by dredging, the south jetty to follow the line of the jetty of 1881.

The natural depth upon the outer bar was 12 feet, and that upon the inner bar 13 feet at mean low tide. The general plan of the work is shown upon the accompanying map.

At the close of the fiscal year ending June 30, 1890, there had been constructed 19,200 linear feet of south jetty, of which 1,200 feet were incomplete. The railway trestle had been extended 428 feet beyond the rock work. The railway is used for transporting material to be deposited in the jetty. The contract under which the work for the fiscal year ending June 30, 1890, was done, expired August 30, 1890, at which date there were 19,400 linear feet of jetty completed, 150 linear feet of incomplete jetty, and beyond that 318 linear feet of trestle and track. The shore branch is included in the foregoing.

Congress, by act approved September 19, 1890, appropriated as follows:

Improving entrance to Galveston Harbor, Texas: Continuing improvement, five hundred thousand dollars: *Provided*, That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the plan contained in the report of the Chief of Engineers for eighteen hundred and eighty-six for the improvement of that harbor, to be paid for as appropriations may from time to time be made by law.

Proposals, to be opened December 27, 1890, for performing work in accordance with that act were invited by public advertisement of 60 days.

At the opening of proposals the lowest bid, that of John H. Mooney and Augustine M. Newton, of New York, was accepted for constructing railway, including trestle, and for furnishing sandstone riprap and granite blocks in place. Mooney & Newton failed to enter into the required contract and, in consequence, the work was readvertised February 28, under the same specifications as before, proposals to be opened March 30. The contract for constructing railway, including trestle, and furnishing sandstone riprap and granite blocks in place was awarded to O'Connor, Laing & Smoot, of Dallas, Tex., they being the lowest bidders for the aggregate of the three items.

This contract was approved June 2, 1891.

Congress, by act approved March 3, 1891 (sundry civil bill), further appropriated the sum of $600,000 for continuing the improvement.

O'Connor, Laing & Smoot commenced construction work on the south jetty under their contract August 1, 1891, having previously repaired the track and trestle.

Owing, to considerable extent, to difficulty in getting sand rock for riprap of the least weight per solid cubic foot required by the specifications, their progress was not as rapid as had been expected. On the 18th of February, last, supplementary articles of agreement were approved by which the least weight of sandstone for riprap was reduced 10 pounds and the price per ton reduced 10 cents. The delivery of material then advanced more rapidly, though the work was retarded in March, April, May, and June by the stormy weather.

According to the specifications, the contractors were to push their work in such manner as to earn the $500,000 appropriated by the act of September 19, 1890 (less the amount necessary for engineering and contingent expenses), by February 2, 1892, and thereafter, their earnings were to be at a rate of not less than one million of dollars a year.

Pending decision upon their application for a modification in sandstone specifications, they were granted an extension of time to March 2 in which to earn the appropriation of 1890, and in consequence of unfavorable weather several other extensions of time were granted them, the last one expiring June 21. At that date they earned the said appropriation.

Since commencing construction work on the south jetty, the contractors have accomplished the following:

Linear feet of completed jetty	4,600
Linear feet of jetty built to average height of one-half foot above mean low tide	2,200
Linear feet of jetty built to average height of 3 feet above foundation	723
Total of complete and incomplete jetty built during the fiscal year ending June 30, 1892	7,523

The total length of south jetty constructed since work began upon it in 1887 is (shore branch included):

Linear feet of completed jetty	24,000
Linear feet of incomplete jetty	2,923
Total number of feet complete and incomplete	26,923

The sea end of the work is now within 5,400 of the outer 12-foot contour, or outer crest of the bar.

In May and June last, the usual annual survey was made of the bar and its channel, and of the harbor generally, to include Bolivar Gorge and the Galveston Channel as far as the foot of Forty-fifth street. The soundings show a depth of 13¼ feet at mean low tide in the outer-bar channel, and a depth of 21 feet where the inner bar was.

The outer-bar channel has increased slightly in width and the distance between the inner and outer 12-foot contours of the outer bar has decreased about 700 feet at a point about 5,000 feet north of the line of the south jetty. The shoal north of the jetty between Fort Point Lighthouse and Station 190 has less water on its crest than it had in 1891, and the accretion of sand between the south jetty and Galveston Island has enlarged. These constitute the principal changes in positions of contours during the past year, as may be seen from inspection of the map herewith.

The soundings are reduced to the plane of mean low tide, which is the plane to which soundings of previous surveys have been reduced. It

is also the plane to which soundings for charts of the U. S. Coast Survey are reduced.

On July 4 and 5, 1891, this locality was visited by a severe storm which displaced a number of the track timbers and also a comparatively small quantity of riprap, as well as some 2 to 3-ton blocks of stone from the jetty. The timbers and blocks displaced were mostly at the sea end of the unfinished work, and the riprap displaced was mostly along the shore branch and at the junction of the jetty with Fort Point. The timbers—some of which had been piled up on the outer end of the jetty, they having been removed from piles that had been acted upon by the teredo—were recovered, with the exception of about half a dozen pieces, and none of the stone was lost. The jetty withstood the storm satisfactorily.

An account of this storm was rendered to the Department, July 23, 1891.

The tide-gauge houses on the outer bar and in Bolivar Gorge were destroyed by that storm. They have since been replaced by more substantial structures, for an account of which, as well as of tidal data, reference is made to the report, herewith, of First Lieut. William C. Langfitt, Corps of Engineers.

For an account, in detail, of the work done by the contractors, and also of the survey of the harbor in May and June, last, please see the appended report of Mr. E. M. Hartrick, assistant engineer.

For the statement of shipments from Galveston, contained in the table of commercial statistics for the year ending June 30, 1892, accompanying this report, I am indebted to Mr. Julius Runge, president of the Galveston Cotton Exchange. For the number, character, and tonnage of vessels entered and cleared for the same period, acknowledgement is due Mr. N. W. Cuney, collector of the port. The statistics for this work and others in charge of this office were compiled by Mr. Elliott Jones, chief clerk.

The comparative tables of statistics herewith, to which attention is invited, show that the shipments of cotton have increased from 1,114,133 bales or 258,638 tons in 1891, to 1,237,937 bales or 287,377 tons in 1892, and that the total tonnage of vessels entered and cleared has increased from 1,073,920 tons in 1891 to 1,134,326 tons in 1892, a net increase of 60,406 tons.

Total expended on the improvement under all projects to June 30, 1891, inclusive	$2,273,920.90
Expended on the present project to June 30, 1891	796,017.88
Expended on present project to June 30, 1892	1,234,940.51

The balance of funds available will be applied to continuing the extension of the south jetty.

The sum of $1,000,000 can be profitably expended during the fiscal year ending June 30, 1894, most, if not all of it, to be applied to construction of the projected north jetty.

Originally estimated cost of the work as revised in 1886	$8,478,000.00
Aggregate amount appropriated to July 1, 1892	3,378,000.00
Total amount expended	2,712,843.53

In addition to this there was expended the sum of $100,000 subscribed by the city of Galveston in 1883.

The work is located in the collection district of Galveston. The nearest light-houses are at Bolivar Point and Fort Point at the entrance to Galveston Bay.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1892, was $161,052.48.

Abstract of appropriations made by Congress for improving harbor at Galveston, Tex.

By act approved—	
July 11, 1870	*$25,000
March 3, 1871	*20,000
June 10, 1872	*31,000
June 23, 1874	60,000
March 3, 1875	150,000
August 14, 1876	142,000
June 7, 1878	75,000
June 18, 1878	50,000
March 3, 1879	100,000
June 14, 1880	175,000
March 3, 1881	250,000
March 4, 1882	100,000
By act passed August 2, 1882	300,000
By act approved August 5, 1886	300,000
By act of August 11, 1888	500,000
By act approved September 19, 1890	500,000
By act approved March 3, 1891	600,000
Total	3,378,000

Money statement.

July 1, 1891, balance unexpended		$1,104,079.10
June 30, 1892, amount expended during fiscal year		438,922.63
July 1, 1892, balance unexpended		665,156.47
July 1, 1892, outstanding liabilities	$19,838.72	
July 1, 1892, amount covered by uncompleted contracts	†618,207.64	
		638,046.36
July 1, 1892, balance available		27,110.11
Amount appropriated by act approved August 5, 1892		450,000.00
Amount available for fiscal year ending June 30, 1893		477,110.11
Amount (estimated) required for completion of existing project		4,650,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF FIRST LIEUTENANT WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1892.

MAJOR: I have the honor to submit the following short progress report on the tidal observations for the fiscal year ending June 30, 1892.

On July 4–5, 1891, just after the close of the last fiscal year, a severe storm occurred which destroyed the tide-gauge house in the Gorge and the one on the Bar, thus leaving only the Government Wharf gauge in operation. This fact has prevented me from making the developments of the tidal data indicated in my last report as desirable. I refer more particularly to those bearing on the tidal prism, slopes, velocities, and, generally, all those data which would naturally be sought for in a study of a tidal harbor.

There have been submitted to you during the year a number of tables regarding tidal slopes, but it is not thought desirable to insert these here in their present state, incomplete from want of sufficient extension.

* These appropriations were mostly expended in small dredging operations prior to the adoption of the project of 1874.

† Balance of the appropriations of September 19, 1890, and March 3, 1891, available for disbursement under present contract.

Some study has been given to the points raised in my last report from Table 6 on, and, so far as it has gone, it has been confirmatory of what has been there said.

Table 4, of my report of last year, has been revised to include the results from all the record obtained, before their stoppage, from the Bar, Gorge, Hannas Reef, Red Fish South, and Red Fish North gauges; also the figures for the Government Wharf gauge have been revised to include record obtained to December 31, 1891. There having been no additional record obtained from the other gauges, viz, Rollover, Morgan Point, and Round Point, the values for them given in Table 4 have not been changed but are reproduced as there given.

The quantities given in the table are the heights of the mean high and low water planes referred to the plane of reference and the mean fluctuations for the various classes of tide (see last report) and mean of all tides for the various gauges.

Mean planes of high and low water and mean fluctuation.

Name of gauge.	G. D. T.			I. D. T.			S. D. T.			M. T.		
	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Bar	+2.09	−0.67	2.76	+1.82	−0.28	2.10	+1.56	+0.34	1.22	+1.82	−0.20	2.04
Gorge	+1.98	−0.29	2.27	+1.81	−0.04	1.85	+1.57	+0.58	0.99	+1.76	+0.07	1.69
Government Wharf	+1.68	+0.07	1.61	+1.54	+0.34	1.20	+1.38	+0.72	0.66	+1.53	+0.41	1.12
Hannas Reef	+1.67	+0.18	1.49	+1.51	+0.29	1.22	+1.40	+0.73	0.67	+1.52	+0.42	1.10
Red Fish South	+1.55	+0.39	1.16	+1.45	+0.51	0.94	+1.34	+0.89	0.45	+1.45	+0.60	0.85
Rollover	+1.65	+0.11	1.54	+1.53	+0.28	1.25	+1.39	+0.54	0.85	+1.51	+0.34	1.17
Red Fish North	+1.46	+0.67	0.79	+1.36	+0.71	0.65	+1.25	+0.94	0.31	+1.37	+0.76	0.61
Morgan Point	+1.29	+0.47	0.82	+1.25	+0.59	0.66	+1.10	+0.69	0.41	+1.21	+0.61	0.60
Round Point	+1.37	+0.50	0.87	+1.36	+0.62	0.74	+1.23	+0.79	0.44	+1.31	+0.65	0.66

The preliminary statement of record available from each gauge is here given revised to include records used in the revision of this table as stated above.

Round Point.—From May, 1887, to March, 1890, of which about 15 months' record is lost.

Morgan Point.—From May, 1887, to March, 1890, of which about 8 months' record is lost.

Rollover.—From May, 1887, to December, 1890, of which about 14 months' record is lost.

Red Fish North.—From July, 1889, to June, 1891, of which about 6¼ months' record is lost.

Red Fish South.—From July, 1889, to June, 1891, of which about 7 months' record is lost.

Hanna Reef.—From July, 1889, to June, 1891, of which about 4 months' record is lost.

Government Wharf.—From May, 1887, to December, 1891, of which about 5 months' record is lost.

Gorge.—From July, 1889, to June, 1891, of which about 5¼ months' record is lost.

Bar.—From April, 1888, to June, 1891, of which about 22 months' record is lost.

On April 11, 1892, by your direction, I hired a schooner and crew of men for the purpose of reërecting the Gorge and Bar tide-gauge houses. Owing to the unprecedented continuance of strong northeasterly, easterly, and southeasterly winds, causing such heavy seas as to prevent work, this operation was not finally completed until June 9, 1892. Of the total number of days, on but nineteen were the schooner and crew employed at the site of the houses, the remainder of the time the sea being too rough, and even on many of these nineteen the water was so rough that work was slow and difficult.

As the destruction of the former structures seemed to indicate that much stronger ones were needed, as both of them vibrated considerably under strong winds and seas, in designing the new ones these points were kept in mind. Both houses are practically 8 feet square. The Gorge house is supported on eight 8 by 8 inch square, coppered, wooden piles drawn together two and two to clasp a square 8 by 8 inch timber forming the corner posts of the house. The Bar house is supported on four solid iron piles 6 inches in diameter from about 2 feet above low water to their lower ends and 4 inches in diameter above. They were driven about 12 feet apart at the corners of a square and then inclined by means of a pump until their heads formed the corners of a square about 7 feet on a side. The piles are provided with two tiers of horizontal and diagonal bracing.

In order that full utility may be made of the record obtained from these gauges the elevation of their zeros should be determined by precise levels.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieutenant, Corps of Engineers.

Maj. CHAS. J. ALLEN,
Corps of Engineers.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1892.

SIR: I have the honor to submit the following report of operations for improving Galveston Harbor, Texas, during the fiscal year ending June 30, 1892.

Condition of work at beginning of fiscal year.—At the beginning of the fiscal year the contractors, Messrs. O'Connor, Laing & Smoot, were employed in removing rails and stringers and securing everything of value in connection with the trestle and track that had been extended in advance to complete the contract of Messrs. A. M. Shannon & Co.

The piles of this trestle had been over a year exposed to the ravages of the *Teredo navalis*, and were so badly honeycombed that they were no longer of any use as a bearing pile, and it was a cause of great satisfaction that most of the stringers and rails had been secured before the storm of July 4 and 5, 1891.

Casualties.—The storm of July 4 and 5, 1891, developed in West Gulf, attaining at Galveston two maximum velocities, one 44 miles per hour from the NE. at 6:50 a. m. on July 5, and one 60 miles per hour from the SE. at 8:05 p. m. of the same day. There were two maximum tides on the 5th, one at 8:00 a. m., when it reached 4.65 feet above M. L. T., and one at 9:50 p. m., when it registered 3.95 feet by the automatic tide gauge at Government Wharf. The damage to the jetty was slight; the shore branch settling in places where the covering of riprap was thin and base narrow. This tendency to scour and settle has been counteracted by strengthening the jetty with an apron of small riprap placed at the toe of the side slopes, where the jetty is only a few feet high. A survey of the bar proper was made immediately after the storm and compared with last annual survey, but no marked change could be detected. A more detailed description of the storm and its effect can be found in my report with accompanying charts and tables of July 22, 1891.

The usual equinoctial disturbances occurred in September, 1891, and March, 1892, with a continuance through the months of April and May and the end of June, fresh gales, rough seas, and high tides more or less retarding progress, but with no damage to the work.

General progress.—The contractors during the month of July were engaged overhauling and repairing trestle and track, laying rails for switch to track scales and yard, and delivered the first stone of the contract on the last day of the month. On the 27th of August the first pile was driven for an advance at the front. The stone received before this date and to the end of August was used in repair of shore branch and other places, the actual work at the front commencing September, 1891.

On September 17, 1891, the delivery of stone was discontinued, as that presented was not up to the specifications. This same month the Government track scales, with special foundation, was completed and put in active use.

The delivery of acceptable sandstone riprap recommenced on the 26th of October, 1891, and the first granite block was received on the 30th of the same month, but it was not until the 11th of April, 1892, that the contractors brought on the work a derrick capable of handling block from 5 to 10 tons, and then not of sufficient capacity to overtake and keep up with the work as it advanced.

Inspection and examination of quarries.—The first stone delivered was from Ledbetter (No. 1), on the Houston and Texas Central Railway. This quarry not furnishing the quantity, a second was opened a few miles from the first (No. 2), but had to be abandoned, as it did not come up to weight. The contractors then moved their plant to Quarry Station on the Gulf, Colorado and Santa Fé Railway, but early in November they began claiming inability to procure the sandstone riprap of the desired weight and in sufficient quantities for the work. Their statement being submitted in writing, a careful examination was undertaken, and the report made on the 23d of December, 1891, by First Lieut. W. C. Langfitt, Corps of Engineers, U. S. Army, and myself.

General inspection.—On the arrival of the stone in the contractors' yard at Fort Point it is inspected as to its hardness, toughness, weight, and durability. The hardness and toughness is determined by the hammer, the weight by specific gravity, viz, immersing a large sample of stone of known weight dry in a tank filled with water, then catching and weighing the displaced water and reweighing the sample wet, the amount of water imbibed by the sample is also noted; using the specific

gravity data and the stone's general appearance durability is determined, supplemented by immersing samples in sea-water and carefully noting distintegration or change of any kind. The stone was also subjected to "M. Brard's method" of testing.

Quarries and per cent of stone received.—The sandstone riprap came in general from Ledbetter Station, on the Houston and Texas Central Railway, and Quarry Station, on the Gulf, Colorado and Santa Fe Railway, with a few tons from Heber stone quarry shipped through Clay Station, on the Montgomery branch of the Gulf, Colorado and Santa Fe Railway. The granite came from Granite Mountain, on the Austin and Northwestern, controlled by the Houston and Texas Central Railway.

Three quarries were opened at Ledbetter, known as Ledbetter No. 1, which sent 7¼ per cent of sandstone riprap received; Ledbetter No. 2 (Kruzer) sent 28¼ per cent; and Ledbetter No. 3 (Wolf Hill) sent 7 per cent; Quarry Station sent 53¼ per cent; and Clay Station 4¼ per cent. Granite Mountain had no competition.

General construction.—The general construction has been modified from time to time, as the exigency of the work demanded, but in general it has been carried on as follows: The trestle is driven from 600 to 800 feet in advance over the old mattress work and the caps, stringers, and rails properly secured by straps, bolts, and spikes. Then large sandstone riprap is unloaded on each side of the track to a height of about three feet from the bottom. In the center and between the mounds thus formed there is unloaded small sandstone riprap to the same height as the mound, the whole forming an apron about three feet thick with a base of about 20 feet on top of the old mattress work. The trestle and apron are continued in advance, and the work which was before an apron is now brought up to M. L. T., with large riprap, the small riprap being filled in as before. This riprap slope is straightway protected with granite block to a little above M. L. T. A bracing gang then comes along and secures the bearing piles above the ravages of the teredo navalis by a system of bracing, which also acts as an anchor and underpinning. Then the crest between and around the bents and under the bracing and underpinning is filled with large and small riprap as before. Then, over this riprap crest is laid selected granite block so as to conform as nearly as possible to the required cross-section. The spaces between the blocks are then filled with large and small riprap properly wedging and leveling off the crest, the whole presenting a comparatively smooth and even surface to the waves.

In placing the crest block and rehandling that which had been unloaded by random dumping a floating derrick has been employed since the 11th of April, 1892. A proper mechanical appliance for handling large block had been promised early in September, 1891, and preparations had been made for this proposed overhead derrick by allowing the contractors to increase the length of the trestle cap, brace and underpin same for the extra load the pile bents would be required to carry. This overhead derrick was finally abandoned after repeated promises of its arrival. Its nonarrival prevented the placing of riprap and large block from going on simultaneously, and various methods had to be resorted to so that the progress of the work should not be retarded; but the incomplete work becoming out of all reasonable proportion to the completed the contractors were required to finish up a reasonable amount of the work before being allowed to carry the jetty further seaward. By the first week in July the contractors have promised to have the necessary plant, and it is to be hoped that the bar will be reached in September, 1892.

Advance of work during the year on South Jetty.—End of completed work June 30, 1891, Station 194. End of work June 30, 1892, Station 269+23, an advance of 7,523 feet of which 4,600 is 5 feet above mean low tide, 2,200 feet at, and a little above mean low tide with 723 feet of an apron 3 feet thick.

TABLE NO. 1.—*Showing the kind and amount of stone used.*

Month.	Cars.	Riprap.	Cars.	Blocks.	Total cars.
July	2	31.66	....	....	2
August	238	4,073.32	....	....	238
September	181	3,124.64	....	....	181
October	127	1,838.04	3	46.06	130
November	536	9,053.72	97	1,726.03	633
December	776	11,288.56	214	4,737.45	990
January	684	7,875.94	226	4,553.42	910
February	1,350	16,556.46	516	9,674.57	1,866
March	941	14,246.83	324	7,590.09	1,265
April	934	15,990.07	520	9,741.04	1,454
May	555	9,742.24	307	5,804.37	862
June	372	6,627.64	333	6,744.17	705
Total	6,696	100,449.12	2,540	50,617.20	9,236

TABLE No. 2—*Showing quantities of stone used and cost of same in the work, and other items of expense, not including office and inspection expenses.*

0 to 79+64 (7,964 feet).

Items.	Tons.	Cost.	Tons. per foot.	Cost per foot.
Riprap	3,067.30	$7,514.89	.39	$0.94
Blocks				
Railway		469.87		.06
Extras		283.93		.04
Total for year	3,067.30	8,268.69	.39	1.04
Previous expenditures	*44,259.96	144,389.10	*5.55	18.13
Grand total		152,657.79		19.17

79+64 to 84+64 (500 feet).

Items.	Tons.	Cost.	Tons. per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$29.50		$0.06
Extras		17.26		.03
Total for year		46.76		.09
Previous expenditures	*5,998.81	16,188.32	*12.00	32.37
Grand total		16,235.08		32.46

84+64 to 95+64 (1,100 feet).

Items.	Tons.	Cost.	Tons. per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$64.90		$0.06
Extras		37.98		.03
Total for year		102.88		.09
Previous expenditures	*9,594.51	28,924.19	*8.72	26.30
Grand total		29,027.07		26.39

95+64 to 107+64 (1,200 feet).

Items.	Tons.	Cost.	Tons. per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$70.80		$0.06
Extras		41.45		.03
Total for year		112.25		.09
Previous expenditures	*13,094.47	41,126.47	*10.92	34.27
Grand total		41,238.72		34.36

107+64 to 138+64 (3,100 feet).

Items.	Tons.	Cost.	Tons. per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$182.90		$0.06
Extras		107.09		.03
Total for year		289.99		.09
Previous expenditures	*72,180.09	215,978.54	*23.28	69.67
Grand total		216,268.53		69.76

* Cubic yards.

TABLE NO. 2—*Showing quantities of stone used and cost of same in the work, and other items of expense, etc.*—Continued.

138+64 to 144+12 (548 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$32.33		$0.06
Extras		18.92		.03
Total for year		51.25		.09
Previous expenditures	*12,567.62	39,069.48	*22.93	71.29
Grand total		39,120.73		71.38

144+12 to 150 (588 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$34.69		$0.06
Extras		20.28		.03
Total for year		54.97		.09
Previous expenditures	*12,740.68	34,280.37	*21.67	58.30
Grand total		34,335.34		58.39

150 to 160 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$59.00		$0.06
Extras		34.55		.03
Total for year		93.55		.09
Previous expenditures	*19,623.31	54,538.59	*19.62	54.54
Grand total		54,632.14		54.63

160 to 170 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap				
Blocks				
Railways		$59.00		$0.06
Extras		47.86		.05
Total for year		106.86		.11
Previous expenditures	*19,679.77	53,709.19	*19.68	53.70
Grand total		53,816.05		53.81

170 to 180 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap				
Blocks				
Railway		$59.00		$0.06
Extras		47.87		.05
Total for year		106.87		.11
Previous expenditures	*13,285.98	38,562.52	*13.28	38.56
Grand total		38,669.39		38.67

* Cubic yards.

TABLE NO. 2—*Showing quantities of stone used and cost of same in the work, and other items of expense, etc.*—Continued.

180 to 190 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	387.70	$949.86	0.39	$0.95
Blocks				
Railway		59.00		.06
Extras		47.87		.05
Total for year	387.70	1,056.73	0.39	1.06
Previous expenditures	*14,490.87	40,860.80	*14.49	40.86
Grand total		41,917.53		41.92

190 to 200 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	11,386.14	$27,761.67	11.39	$27.76
Blocks	5,410.07	22,992.80	5.41	22.99
Railway		2,737.68		2.74
Extras		72.66		.07
Total for year	16,796.21	53,564.81	16.80	53.56
Previous expenditures	*8,531.53	24,305.73	*21.02	24.31
Grand total		77,870.54		77.87

200 to 210 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	15,517.55	$37,792.71	15.52	$37.79
Blocks	8,698.60	36,969.06	8.70	36.97
Railway		4,422.47		4.42
Extras		87.72		.09
Total for year	24,216.15	79,271.96	24.22	79.27

210 to 220 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	13,774.16	$33,474.09	13.77	$33.47
Blocks	8,502.71	36,136.52	8.50	36.14
Railway		4,343.36		4.34
Extras		76.51		.08
Total for year	22,276.87	74,030.48	22.27	74.03

220 to 230 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	12,641.06	$30,713.03	12.64	$30.71
Blocks	8,351.00	35,491.74	8.35	35.49
Railway		4,340.00		4.34
Extras		71.65		.07
Total for year	20,992.06	70,616.42	20.99	70.61

230 to 240 (1,000 feet).

Items.	Tons.	Cost.	Tons, per foot.	Cost per foot.
Riprap	14,224.90	$33,428.52	14.22	$33.43
Blocks	8,493.19	36,096.06	8.49	36.09
Railway		4,340.00		4.34
Extras		70.56		.07
Total for year	22,718.09	73,935.14	22.71	73.93

* Cubic yards.

TABLE No. 2—*Showing quantities of stone used and cost of same in the work, and other items of expense, etc.*—Continued.

*240 to 250 (1,000 feet).

Tons.	Tons.	Cost.	Tons, per foot.	Cost, per foot.
Riprap	11,555.23	$27,184.37	11.55	$27.18
Blocks	4,558.55	19,373.82	4.56	19.37
Railways		4,340.00		4.34
Extras		38.51		0.04
Total for year	16,113.78	50,936.70	16.11	50.93

*250 to 260 (1,000 feet).

Riprap	12,239.22	$28,762.16	12.25	$28.76
Blocks	4,791.75	20,364.94	4.79	20.37
Railway		4,432.67		4.43
Extras		32.57		.03
Total for year	17,030.97	53,592.34	17.03	53.59

*260 to 269+23 (923 feet) (723 feet of apron).

Riprap	5,655.86	$13,291.27	6.13	$14.40
Blocks	764.75	3,250.19	.83	3.52
Railway		3,836.58		4.16
Extras		22.41		.02
Total for year	6,420.61	20,400.45	6.96	22.10

Sections starred thus (*) are complete only to mean low tide and therefore subject to revision for final cost.

TABLE No. 3.—*Synopsis showing average cost per foot between the following stations.*

[Cost per foot includes railway and extras.]

Stations.	Distance.	This year	To date.	Remarks.	
	Feet.	*Per foot.*	*Per foot.*		
From 0 to 79+64	7,964	$1.04	$19.17	Shore connection.	
79+64 to 84+64	500	.09	32.46	Across old channel.	
84+64 to 95+64	1,100	.09	26.39		On old mattress work.
95+64 to 107+64	1,200	.09	34.36	Clay core	
107+64 to 138+64	3,100	.09	69.76	...do	
138+64 to 144+12	548	.09	71.38	...do	
144+12 to 150	588	.09	58.39		
150 to 160	1,000	.09	54.63		
160 to 170	1,000	.11	53.81		
170 to 180	1,000	.11	38.67		
180 to 190	1,000	1.06	41.92		
190 to 200	1,000	58.56	77.87		
200 to 210	1,000	79.27	79.27		
210 to 220	1,000	74.03	74.03		
220 to 230	1,000	70.61	70.61		
230 to 240	1,000	73.93	73.93		
*240 to 250	1,000	50.93	50.93	Unfinished	
*250 to 260	1,000	53.59	53.59	...do	
*260 to 269+23	923	22.10	22.10	Unfinished (723 feet of apron.)	

Sections starred thus (*) are complete only to mean low tide and therefore subject to revision for final cost.

Annual survey.—The survey was commenced in May and finished in June, 1892; sufficient field notes have been plotted for the annual comparative chart; the large chart will be forwarded as soon as possible.

By comparing the chart with that of last year's there is no decided change in the curves of depths. The movement in advance and recession can not be definitely de-

termined as sometimes a few tenths of a foot in depth will change the location of a curve in certain locations several hundred feet.

The outer bar has a minimum width on crest between the 12-foot curves of 750 feet, and a channel through the bar in this location may be looked for at any time. This tendency toward a new bar channel is nearly in the center, and between the south and proposed north jetty.

The present outer bar channel has the same depth as last year, 13¼ feet at mean low tide, with a tendency to greater width of channel between the 13-foot curves.

The inner bar channel shows a tendency to a greater width of channel between the navigable lines, and maintains its depth, a good 21 feet.

Since last survey a 12-foot trench, with a maximum depth of 14 feet, has been developed on the north side of jetty from station 250, gulfward; it is similar to the trench on the south side, which maintains the same depth and width as formerly.

The island which appears on the chart of 1891 south of station 150 is no longer isolated, but forms part of Galveston Island. The shore line in this location has advanced 600 feet, extending toward station 170, running southwesterly and coinciding with the shore line of 1891 at Second street.

The shoal north of the jetty between Fort Point Light-House and station 190 has less water on its crest and is uncovered at lower low water, the curves of depth surrounding this shoal remain about the same.

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1892.

Tonnage of vessels and revenue collected.

[From statement furnished by N. W. Cuney, esq., collector of the port.]

Steam vessels entered	345
Sailing vessels entered	137
Total	482
Steam vessels cleared	342
Sailing vessels cleared	62
Total	404
Total tonnage of vessels entered	587,216
Total tonnage of vessels cleared	547,110
Total tonnage	1,134,326
Amount of revenue collected	$161,052.48

Amount and value of freight shipped.

[From statement furnished by Mr. Julius Runge, president Galveston Cotton Exchange.]

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (1,237,937 bales)	287,377	$44,565,000	$4,952,000
Cotton-seed cake and oil	62,114	1,197,000	343,000
Corn and wheat	23,068	794,000	116,000
Ore	8,100	729,000	38,000
Wool	6,974	2,927,000	91,000
General merchandise	5,778	1,048,000	56,000
Total	393,411	51,260,000	5,596,000

Increase of freight carried over last year, 63,393 tons.
Increase of tonnage of vessels over last year, 60,406 tons.

Comparative statement of commercial statistics of the port of Galveston, Texas, for the fiscal years ending June 30, 1887, 1888, 1889, 1890, 1891, and 1892.

Years.	Vessels entered.		Vessels cleared.		Tonnage.		Total.	Cotton shipped.	Other merchandise.	Revenue collected.
	Steam.	Sailing.	Steam.	Sailing.	Entered.	Cleared.				
								Tons.	*Tons.*	
1887	250	296	256	238	446,711	444,801	891,512	....	....	$172,894
1888	259	231	249	193	447,144	432,588	879,732	....	....	234,908
1889	250	131	244	124	416,468	403,896	820,364	....	....	153,040
1890	302	145	304	118	501,695	492,677	999,372	223,486	86,023	131,613
1891	342	139	345	96	544,862	529,058	1,073,920	258,638	71,980	174,489
1892	345	137	343	62	587,216	547,110	1,134,326	287,377	106,034	161,052

U 2.

IMPROVEMENT OF SHIP CHANNEL IN GALVESTON BAY, TEXAS.

The project for this improvement, adopted in 1871 and modified in 1877, consisted in excavating a channel at least 12 feet deep and with a width at bottom of 100 feet through Galveston Bay from Bolivar Channel to Morgan Cut, a distance of about 18.9 miles, the average natural depth in the bay on the line of this channel having been about 8½ feet at mean low tide.

This channel connects with Morgan Cut and Morgan Canal, the works of the Buffalo Bayou Ship-Channel Company, the cut and canal extending from Galveston Bay, through Morgan Point, to San Jacinto River. (Please see map herewith.)

The Buffalo Bayou Ship-Channel Company agreed, in 1881, to surrender to the United States its works at Morgan Point, together with its charter and the rights under it, upon the completion, by the Government, of the ship channel in Galveston Bay. This channel was completed by the Government in July, 1889.

Congress, by act approved September 19, 1890, provided for the appointment of a commission of engineer officers to appraise the value of the company's works, and also provided for the payment to the company of the amount of the said appraisement. The works were taken possession of by the Government May 4, 1892, and the canal made free to navigation.

For information in detail concerning the acquisition of the works at Morgan Point, reference is here made to Appendix U to the Annual Report of the Chief of Engineers for the fiscal year ended June 30, 1891.

The river and harbor act of Congress, approved September 19, 1890, appropriated as follows:

Improving and maintaining Ship Channel in Galveston Bay, Texas, from Bolivar Channel, through Morgan Cut and Morgan Channel, constructed through Morgan Point, to the San Jacinto River, $40,000.

But application of this appropriation to improvement had to be deferred until the works at Morgan Point should be transferred to the United States.

In consequence, operations for the past fiscal year have consisted in repairing the beacons which mark the ship channel, and in making examination and survey of the channel.

The erection of the beacons was authorized by the river and harbor act of August 5, 1886.

The work of dredging the channel, which was suspended in 1883, was resumed in February, 1888, and a 12-foot channel completed from Bolivar Channel to Morgan Cut, July 20, 1889, since which date no dredging has been done. The average depth of the excavation was 13.15 feet at mean low tide.

The condition of the dredged channel at the close of June, 1889, is described in the Annual Report for that year as follows:

A resurvey of the entire length of the channel was made in June (1889). It shows a marked deterioration of the channel through the lower bay, where the greatest length of time has elapsed since the work was done. Considering the portion of the channel, 9.93 miles in length, extending from Bolivar Channel to Red Fish Bar, the average length of time which had elapsed since the execution of the work was ten months. The average depth of the bay before the excavation was 8.63 feet. The average depth of the channel after excavation was 13.15 feet, making an average depth of excavation of 4.52 feet. The average depth of the channel was found in June to be 11.61 feet, which shows an average fill of 1.54 feet, or 34 per cent, in ten months. In my annual report for 1887 I stated that if the channel between Bolivar Channel and Red Fish Bar be maintained at the full depth of 12 feet it will require the removal each year of not less than 30 per cent of the amount originally excavated. (See Annual Report Chief of Engineers for 1887, page 1420). These views have been fully confirmed.

In the upper bay the average period which had elapsed since the execution of the work was, in June, only two months, and no important deterioration was detected by the survey.

An examination of the channel made in June, 1890, showed a ruling depth of 10 feet, the dredged depth which remained in June, 1889, in the lower bay (Bolivar Channel to Red Fish Bar), having shoaled 40 per cent, while the depth of excavation in the channel in the upper bay (Red Fish to Morgan Cut) had, in fourteen months, shoaled to an extent represented by 24 per cent of the original excavation.

An examination of the channel from Bolivar Channel to Morgan Cut, made June 23, 1891, disclosed a ruling depth for that distance of 9 feet, the average depth being somewhat more, and the recent examination showed the ruling depth to be 8.6 feet, the average depth being 9.7 feet. The depths are those at mean low tide.

The acquisition of the works at Morgan Point adds to the Galveston Ship Channel the following:

	Miles.
Morgan Cut, length	4.8
Morgan Canal, length	.63
Total	5.43

The ruling depth in Morgan Cut, which was originally dredged by the Buffalo Bayou Ship-Channel Company to a depth of about 16 feet, is now but 7½ feet.

This addition of 5.43 miles of cut and canal to the ship channel in Galveston Bay, renders necessary an estimate for the excavation throughout the entire extent of 24.33 miles to obtain a depth of 12 feet at mean low tide, with width of channel, at bottom, of 100 feet, and for the maintenance of that depth, care and preservation of revetments, etc.

The estimated total cost of the 18.9 miles of ship channel in Galveston Bay, as revised in 1888, was $740,108.22, in addition to which the annual cost of maintaining the width and depth, after completion of the original excavation, was placed at $80,000.

As already said, no dredging has been done in the ship channel since July, 1889. The dredging, which commenced in February, 1888, was carried to an average depth of 13.15 feet, though the quantity of material excavated below the 12-foot depth was not paid for, such being the terms

of the contract under which the dredging was done. The average depth now in this channel is 9.7 feet, as already said.

The average depth in Morgan Cut is 8 feet.

To restore both channels to a least depth of 12 feet, with width at bottom of 100 feet, will require the excavation of about 1,869,995 cubic yards of material.

Seven thousand three hundred and sixty linear feet, approximately, of the banks of Morgan Canal require revetment, and portions of the banks should be relieved of the superincumbent masses of material thrown upon them when the canal was excavated, and portions, also, of the banks should be sloped.

The total cost of the improvement, including fences on the right of way, necessary small buildings for watchmen and other employés that may at times be engaged upon the canal, is thus increased from $740,108.22 (which was the estimate given in the last Annual Report for ship channel in Galveston Bay alone) to $896,175.44.

The amounts appropriated and expended to July 1, 1892, as well as the amount needed to complete the work are given below.

The estimated annual cost of maintaining the dredged channels after the excavation is completed is placed at $100,000, instead of $80,000, which was the estimate for maintenance before the works at Morgan Point came into possession of the United States.

The ship channel is one link in the navigation from Houston to the Gulf of Mexico, the other links being San Jacinto River and Buffalo Bayou, on which Houston is situated.

It is not practicable to give exact statistics of the commerce through the ship channel. Almost the entire floating commerce of Buffalo Bayou, of San Jacinto River, of Trinity River, and of Cedar Bayou is carried through this channel. Commercial statistics of those streams are given in the annual reports of pertaining improvements.

It is believed by many of the best informed men of Houston that the advantages to be derived from enabling sea-going ships to reach Houston by way of the ship channel and Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. The annual report of Buffalo Bayou gives as full statistics of the freight carried upon that stream as could be obtained. It is carried in barges drawing 5 feet when fully loaded and towed by tugs drawing 7 feet and less. These cross Galveston Bay, but the depth of water is already sufficient for them. A large proportion of this freight would be loaded directly upon sea-going vessels if they visited Houston. One item of shipment by water down Buffalo Bayou from Houston during the past fiscal year was 336,654 bales of cotton, an increase over the shipments of last year of 39,062 bales.

Total expended on this improvement to June 30, 1891	$536,228.43
Total expended during fiscal year ending June 30, 1892	4,602.73
Original estimated cost of this work as revised in 1892	896,175.44
Aggregate amount appropriated to July 1, 1892	586,500.00
Amount expended to July 1, 1892	540,831.16
The amount required for maintenance after the completion of the original excavation (annually)	100,000.00

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half Moon Shoal, and Red Fish Bar. The amount of revenue collected at the port of Galveston during the fiscal year ending June 30, 1892, was $161,052.48.

Abstract of appropriations made by Congress for improving ship channel in Galveston Bay, Texas.

By act approved—	
March 3, 1875	$25,000
August 4, 1876	72,000
June 18, 1878	75,000
March 3, 1879	80,000
June 14, 1880	50,000
March 3, 1881	50,000
By act passed August 2, 1882	94,500
By act of August 11, 1888	100,000
By act of September 19, 1890	40,000
Total	586,500

It is proposed to apply the appropriation of $40,000 made by act of Congress approved September 19, 1890, and the balance of funds from former appropriations to dredging, to construction of necessary revetment to the banks of the canal at Morgan Point, and to maintenance of the beacons marking the ship channel.

The amount that can be profitably expended during the fiscal year ending June 30, 1894, is $200,000, to be applied to dredging, construction of necessary revetment of canal banks, and care of beacons.

For detailed statement of work done on survey of ship channel, please see report herewith of Mr. Gerald Bagnall, Assistant Engineer.

Money statement.

July 1, 1891, balance unexpended	$50,271.57
June 30, 1892, amount expended during fiscal year	4,602.73
July 1, 1892, balance unexpended	45,668.84
July 1, 1892, outstanding liabilities	95.69
July 1, 1892, balance available	45,573.15
Amount appropriated by act approved July 13, 1892	40,000.00
Amount available for fiscal year ending June 30, 1893	85,573.15
Amount (estimated) required for completion of existing project	269,675.44
Amount that can be profitably expended in fiscal year ending June 30, 1894	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 25, 1892.

SIR: I have the honor to make the following report for the ship channel for the fiscal year ending June 30, 1892:

During July, August, and September the schooner *Andrew Boden* was engaged on the maintenance and repairs of beacons and triangulation stations. From September until March no work was done.

On March 1 a party was organized to retriangulate the bay from Galveston to Morgan Point, many of the old stations having been lost, and to make a hydrographic survey of the ship channel to Morgan Beacon. Owing to bad weather the party did not get started until March 9, and for the same reason the survey has progressed very slowly.

On May 4 Morgan Cut and Canal were formally turned over to the United States, and they were added to the area to be surveyed.

At the end of the fiscal year the hydrographic work was finished from Bolivar Channel to and through Morgan Canal and the triangulation nearly finished. The boundary lines of the right of way of the canal were also laid out and marked with stakes.

As the survey has not yet been plotted it is impossible to give exact results, but the shoaling of the dredged channel appears to go on about at the usual rate, *i. e.*, about 30 per cent of the cut remaining at the end of the last fiscal year.

The ruling depth from Bolivar Channel to Morgan Beacon is 8.6 feet, and the average depth 9.7 feet, and from Morgan Beacon to Morgan Canal the ruling depth is 7.6 feet, and the average 8 feet. Through the canal the depth remains about the same as last year.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

U 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

The Trinity River empties into Galveston Bay through several mouths or passes near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably. The one generally used by vessels of late years is the Middle Pass. The channel depth in the river immediately above the passes is 16 feet or more. The depth in the Middle Pass is 9 feet or more. Opposite the mouth of each of the passes is a bar, the depth upon the crest of that of the Middle Pass being now 3 feet 6 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches. To accommodate them there should be a channel 5½ feet to 6 feet deep.

It was stated upon page 539 of the Annual Report of the Chief of Engineers for 1871, that Pass A, or the Southeast Pass, was excavated by the Government in 1865 to facilitate the supply of fuel to the troops stationed in Galveston. This improvement was subsequently obliterated by natural causes. In 1880 a channel was dredged across the bar at the mouth of Middle Pass, its length being 4,800 feet, its average width 110 feet, and its least depth 5½ feet, the amount of material removed being 47,300 cubic yards. (See Annual Report Chief of Engineers 1881, page 1,341.) This channel was also obliterated by natural causes. In the winter of 1884 and spring of 1885 a channel was again dredged through the bar at the mouth of Middle Pass to a least depth of 6 feet, its length being 3,750 feet. A wooden revetment was placed upon the west side of the channel for a length of 2,775 feet, and upon the east side for a length of 1,280 feet, the object of which was to prevent the excavated material deposited near by from flowing back into the cut. The Annual Report for 1887 stated that the channel had shoaled in some places, that additional dredging was needed, and that the revetment required repairs and extension. The cost of the necessary work was estimated at $25,000.

An appropriation of $12,500 for continuing the improvement having been made in the river and harbor act of August 11, 1888, a survey was undertaken in April following to ascertain the condition of the bar and of the works executed for its improvement in 1884–'85.

The condition of the old works and bar, as found from that survey, is stated as follows in the Annual Report for 1889:

The channel, though not obliterated, has shoaled considerably, and had a least depth at one point of only 3 feet 2 inches. The west revetment is in fair condition

for a length of 1,800 feet from its upstream end, the remaining 975 feet being much damaged. The east revetment is in good condition for a length of 300 feet from its downstream end; of the remainder only the piles remain. Evidence of the action of the teredo is found in the downstream end of the west revetment, but for most of the distance the wood appears to have been protected by the presence of fresh water.

From the results of the survey it appeared best to construct two parallel jetties of timber, to extend from the mouth of the middle pass across the bar and into 6 feet depth of water in Galveston Bay, and to close, by means of submerged dams or sills, the other principal passes, the jetties to be placed about 275 feet apart and to have a total length of 15,350 feet; the length of the west jetty to be 7,750 feet, and that of the east jetty, 7,600 feet; as much of the old work as might be serviceable to be embodied in the west jetty.

The total cost of the foregoing, including removal of so much of the east revetment as might remain after completion of the work, was placed at $55,000. This plan and estimate was approved in 1889. Adding to the foregoing sum the amounts expended for dredging, etc., under former appropriations the revised estimated cost of the improvement was brought up to $89,500.

Under the appropriation made by act of August 11, 1888, 3,269 linear feet of west jetty were built. The result of the work, as stated in my last annual report, was a slight deepening in the channel running parallel with the line of new jetty, an increase in depth on the bar of about 4 inches, and a straightening of the channel, making the crossing of the bar easier than it was before the improvement commenced in 1889.

Congress, by act approved September 19, 1890, appropriated $10,000 for continuing the improvement. This sum was applied to construction of 1,360½ linear feet of west revetment, sufficient to join it to the old revetment, and to repairs of such portions of the old west revetment as might be utilized in the work, and to contingencies.

The repairs were made by hired labor. The construction of 1,360½ feet was by contract entered into with J. J. Atkinson, of Houston. The contract closed June 30, 1891.

Work during the fiscal year ending June 30, 1892:

The repairs to the old west revetment, begun in May, 1891, were completed in July, adding to the improvement 1,530 feet of effective jetty. These repairs were made by hired labor.

The aggregate of completed west jetty is therefore 6,159 feet.

During the month of June past the heads of the piles in the jetty were protected by a coating of tar and river sand.

The depth on the bar remains practically the same as it was last year, viz, 3½ feet at mean low tide.

The amount required to complete the work is $32,500, which can be profitably expended during the fiscal year ending June 30, 1894.

For an account in detail of the work of the past fiscal year, reference is made to the report, herewith, of Mr. Gerald Bagnall, assistant engineer.

A special agent was employed during the year to keep a record of the commerce and tonnage of the river. Statistics compiled from his report are herewith. It appears from the comparative statement of statistics that the shipment of freight during the past fiscal year is slightly less than that for the preceding year.

Amount expended to include June 30, 1891	$52,822.21
Amount expended during the past fiscal year	3,297.47
Total expended upon the improvement to include June 30, 1892	56,119.68

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING TRINTY RIVER, TEXAS.

By act approved—	
June 18, 1878	$10,000
March 3, 1879	2,500
June 14, 1880	4,000
March 3, 1881	10,000
By act passed August 2, 1882	8,000
By act of August 11, 1888	12,500
By act approved September 19, 1890	10,000
Total	57,000

Of this amount, the sum of $7,500 was expended in 1882 in removing obstructions between Liberty and the mouth of the river.

It is proposed to apply the balance of funds towards keeping the work in repair.

The sum of $32,500 can be profitably expended during the fiscal year ending June 30, 1894, in completing the work.

The work is located in the collection district of Galveston. The nearest light-house is at Red Fish Bar. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1892, was $161,052.48.

Money statement.

July 1, 1891, balance unexpended	$4,177.79
June 30, 1892, amount expended during fiscal year	3,297.47
July 1, 1892, balance unexpended	880.32
July 1, 1892, outstanding liabilities	86.00
July 1, 1892, balance available	794.32
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	10,794.32
Amount (estimated) required for completion of existing project	22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	22,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 22, 1892.

SIR: I have the honor to make the following report on the improvement at the mouth of Trinity River, Texas, for the fiscal year ending June 30, 1892:

The repairs on about 1,176 feet of the work of 1884–'85, which had been about three-fourths done at the end of the last fiscal year, were completed in July.

During the same month 55 new sheet-piling were driven in the work of 1890 and 200 in the work of 1884–'85, completing the repairs on the latter to a distance of 1,530 feet from its inner end. Over all this repaired portion two new top stringers were put on immediately under the old ones and the lower ones replaced over a great portion of the length, the whole being well bolted with three-fourths inch and one-half inch bolts. The heads of the piles of the work of 1890 were, at the same time, given a coat of tar.

In order to make these repairs it was necessary to hire a barge with a steam pile-driver and blacksmith shop, for which a compensation of $15 a day was paid.

On the 30th of July, the repairs having been completed as far as the old work was considered worth repairing, the force was transported to Galveston and paid off.

In June, 1892, it having been found that some of the piles of the work of 1890 had commenced to decay, it was considered advisable to protect them further and the

heads of the piles and the sheet-piling of the work of 1890-'91 were accordingly given a coating of tar and sand.

At the close of the fiscal year ending June 30, 1892, the depth over the bar at the mouth of the river was practically the same as at time of last survey.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

[Compiled from reports rendered by Special Agent T. A. Kilgore, of Wallisville, Tex.]

Vessels using the river, 30; 26 sailing vessels and 4 barges. Length on deck, 32 feet to 120 feet; draft, 2 feet 8 inches to 5 feet 6 inches; tonnage, 6 tons to 150 tons; trips made during the year, 1,100; total tonnage, 13,994 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton	37	$6,868	$179
Lumber	8,753	28,208	9,947
General merchandise	794	26,734	2,923
Total	9,584	61,810	13,049

Decrease since last year, 370 tons.

Comparative statement of commercial statistics of Trinity River, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, 1891, and 1892.

Year.	Vessels using river.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.	Transported. Cotton.	Transported. Lumber.	Transported. General merchandise.	Transported. Total weight.	Total value of cargoes.	Total freight charges.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	32	65	4.7	32	1,217	15,958	226	11,863	855	12,944	$88,704	$17,027
1889	36	65	4.5	32	1,330	16,737	148	10,872	1,159	12,179	75,902	17,276
1890	33	80	5.5	80	1,221	16,887	102	10,906	719	11,727	46,347	14,249
1891	30	80	5.5	80	1,115	15,733	38	9,364	552	9,954	47,034	13,582
1892	30	120	5.6	150	1,100	13,994	37	8,753	794	9,584	61,810	13,049

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IMPROVEMENT OF CEDAR BAYOU, TEXAS.

A survey of this locality with view to removal of the bar at the mouth of the bayou was made in 1889, in accordance with the requirements of sections 13 and 14 of the river and harbor act of Congress of August 11, 1888. The results were embodied in a report published in House Ex. Doc. 84, Fifty-first Congress, first session.

Congress, by act of September 19, 1890, appropriated as follows:

Improving Cedar Bayou, Texas, by removal of bar at the mouth of said bayou where it empties into Galveston Bay: completing improvement, eighteen thousand one hundred and fifty dollars.

This sum was the estimated cost, in the report above referred to, of dredging a channel 100 feet wide to afford a depth of 5 feet at mean low tide, and of protecting the cut on each side from action of waves and currents by walls or revetments, which would serve also to maintain dredge spoil in place. The material for revetment that then seemed advisable, on account of cost, was timber, it appearing from statements made to this office that fresh water from the bayou and San Jacinto River would temper the salt water sufficiently at the mouth of the bayou, excepting during severe drought, to reduce the activity of the teredo, and to thus make it probable that timber revetment could be relied upon to last for a number of years at that locality. In December, 1890, however, I made a personal examination of the locality, going up the bayou for about 3 miles. I found the bayou water for that distance full as salty as was the water of Galveston Bay. This fact induced me to recommend that the walls be built of brush and stone instead of timber, incorporating with the material a considerable portion of dredge spoil. Brush under such circumstances is expected to resist action of the teredo much better than unprotected timber would.

It was found that the cost of brush and stone walls or revetment would exceed by about $9,000 that of timber revetment, as estimated in the report of the survey of 1889. In that report the probable necessity of occasional redredging was stated in the following words:

> Some additional dredging may occasionally be required at the entrance to and in the channel in order to maintain the depth.

For such dredging it was estimated in the Annual Report for 1891 that $5,000 should be available when needed. This item, added to that required for completing the revetment, the sum, amounting to $14,000, was given in the last Annual Report as the sum that could be advantageously appropriated for the fiscal year ending June 30, 1893. The revised estimate of cost, then, was $32,150.

The project for the improvement, approved May 12, 1891, provides for dredging to afford a depth of 5 feet at mean low tide; the width of cut about 100 feet. And for revetment walls, jetties in fact of brush and stone mattress, with more or less dredge spoil incorporated with the material, the jetties to rise 2 to 2½ feet above mean low tide.

Proposals for performance of work under the appropriation of September 19, 1890, were invited through public advertisement, dated June 25, 1891. At the opening of proposals July 25, 1891, A. M. Shannon & Co. were the lowest bidders, and a contract with them was entered into by the United States. (Please see abstract of proposals herewith.)

The work commenced September 14, 1891, to be completed by January 15 following. An extension of time to February 15 was granted the contractors, but the contract was not completed.

Completion of the work under the appropriation of 1890 was then undertaken in March, 1892, by hired larbor and purchase of materials and procurement of dredging in open market.

By the close of the fiscal year there had been completed the following:

By contract: 509.44 cords of brush mattress in place; 1,568.23 cubic yards of stone in place.

By hired labor and purchase of materials and procurement of dredging in open market: 324 cords of brush mattress in place; 710 cubic yards of stone in place; 10,350 cubic yards of dredging.

The total of work accomplished during the fiscal year was:

Cubic yards of dredging	10,350
Cords of brush mattress work in place	833.44
Cubic yards of stone in place	2,278.23

The resulting dredged channel is 1,840 feet long by 64 feet in width and 5 feet ruling depth at mean low tide, though the ruling depth at present over the approaches to the cut is 4 feet. The material excavated below the depth of 5 feet at mean low tide was not to be, and was not, paid for.

The original ruling depth on the bar at mean low tide was 3 feet.

Completion of the work requires the construction of about 2,200 linear feet more of brush and stone wall and the dredging of about 1,900 linear feet more of channel.

For details of the work please see report, herewith, of Mr. R. B. Talfor, assistant engineer.

Commercial statistics compiled from statements of Messrs. E. McLean and W. O. Jefrey & Bro. are herewith. It appears from the comparative statement of statistics that the shipment of freight during the past fiscal year is 792 tons greater than for the previous year.

Amount expended during the past fiscal year, $13,258.22.

Abstract of appropriations made by Congress for improving Cedar Bayou, Texas.

By act approved September 19, 1890 .... $18,150

The sum of $14,000 can be profitably expended during the fiscal year ending June 30, 1894, in dredging and construction of brush and stone walls.

The work is located in the collection district of Galveston. The nearest lighthouse is at Red Fish Bar. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1892, was $161,052.48.

Money statement.

July 1, 1891, balance unexpended	$18,150.00
June 30, 1892, amount expended during fiscal year	13,258.22
July 1, 1892, balance unexpended	4,891.78
July 1, 1892, outstanding liabilities	2,918.10
July 1, 1892, balance available	1,973.68
Amount appropriated by act approved July 13, 1892	14,000.00
Amount available for fiscal year ending June 30, 1893	15,973.68

Abstract of proposals for improving Cedar Bayou, Texas, received in response to advertisement dated June 25, 1891, and opened July 25, 1891, at Galveston, Tex., by Maj. Charles J. Allen, Corps of Engineers.

No.	Name and address of bidder.	Dredging 25,000 cubic yards, per yard.	Brush mattress in place (550 cords) per cord.	Stone in place (3,200 cubic yards), per yard.	Amount.
		Cents.			
1	Charles Clark, Galveston, Tex	28	$7.00	$2.50	$18,850.00
*2	A. M. Shannon & Co., Galveston Tex	24	6.00	2.50	17,300.00

*No. 2 lowest; acceptance recommended.

Amount available, $15,000 of the $18,150 appropriated by act of September 19, 1890.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1890.

SIR: I have the honor to submit the following report of operations for the improvement of Cedar Bayou Bar, Texas, for the fiscal year ending June 30, 1892:

The project for improvement was to dredge a channel through the bar 100 feet bottom width to a depth of 5 feet at mean low tide, the material to be excavated to be deposited on and behind retaining walls made of brush and stone. The whole work to be done by contract. The contract was awarded to A. M. Shannon & Co., who began operations September 14, 1891.

Construction of north jetty.—The first mat was laid on the line of north jetty September 22, 1891, the last one October 29, 1891, making the north jetty a total length of 1,088 feet. Shore connection was made by digging a trench 50 feet long by 6 feet wide by 3 feet deep at the extreme inner end, and the trench filled with a single row of fascines 1 foot in diameter covered with stone and replaced earth. Eighteen mats, 12 feet by 24 feet by 1 foot, constructed of an upper and lower grillage of poles, between which a filling of fascines 9 inches in diameter was placed, these fascines being made of straight live brush tightly bound at 3-foot intervals. Fourteen of these 12-foot by 24-foot by 1-foot mats were crowned with a row of fascines, three under with one on top, giving an additional height of 2 feet to the center of jetty.

From the eighteenth mat out, a lower course of nineteen mats 18 feet by 32 feet by 1 foot were placed, on which was an upper course of 12-foot by 24-foot by 1-foot mats breaking joints with lower course. At the outer end of this jetty one mat 24 feet by 48 feet by 1 foot was placed; 1,089.01 cubic yards of stone were used for sinking and coping the entire length of this jetty, giving a height of 2¼ feet above mean low tide.

Construction of south jetty.—First mat 18 feet by 32 feet by 1 foot was laid with its inner end on shore October 30. This bottom course of mats is 18 feet by 32 feet by 1 foot, and the top course is of 12 feet by 32 feet by 1 foot, overlapping and breaking joints with lower course. The inner portion of this jetty (776 feet from shore) is built as described, and ballasted with stone to a height of about 1 foot above mean low tide. At this point (776 feet from shore) a gap 400 feet was left over the old channel crossing the bar. This channel was finally closed June 10, 1892, after the new channel was opened by dredging.

From the gap out there were placed twenty-eight 18-foot by 32-foot bottom and two top mats 12 feet by 32 feet, the remaining mats being crowned with six 32-foot fascines each (four below and two on top), giving a cross-section of uniform slope to stone coping.

Dredging.—On October 30 the contractors began dredging operations near the gap with a barge fitted up with a suction apparatus. After six weeks' trial this was abandoned, as the required depth could not be obtained, the suction not being able to dislodge the stiff clay bottom underlying the soft material on top.

On January 4, 1892, the contractors placed an Osgood dipper dredge with a floating derrick to assist the work, dredging from the outer end of north jetty in, the derrick being used to convey and deposit the dredged material to and behind the south jetty, or to the required distance from the edge of cut as prescribed in specifications. Very little was done by this plant, owing to the lack of necessary supplies needed for the running of same. This and the jetty work were finally abandoned by the contractors on February 13, 1892.

On April 24, 1892, active operations were again resumed under the direction of the U. S. Engineer Department. A contract was made with Capt. J. J. Atkinson to dredge a channel 60 feet wide by 5 feet deep at mean low tide. To attain this depth (5 feet) across the shoal a total of 13,993 cubic yards were taken out on this cut, of which the contractors received payment for 10,350 cubic yards, being the amount of material removed to the 5-foot depth; the excess, 3,643 cubic yards, was due to the draft of his dredge (4 feet), and an allowance for low tides on the bar, on which there was but 2 feet at mean low tide.

The south edge of the cut is 57 feet from the axis of the south jetty, leaving a berm of 48 feet between jetty and edge of cut. The average depth done by dredge was about 6¼ feet below mean low tide, with an average bottom width of 64 feet. A fill of from one-half to 1 foot has taken place on the south side of the cut, due to the overwash of the material dumped behind and south of crest of south jetty. This dump when first placed reached a height of about 6 feet above water surface, and is being gradually washed down by the action of the waves, the largest portion of which is carried back from the jetty by the receding wave or undertow for a distance varying from 40 to 100 feet, according to the size and height of dump. (See cross section of cut.)

Work resumed under the direction of the Engineer Department, U. S. A.—The contract-

ors having failed to complete the work after an extension of one month's time (January 15 to February 15, 1892), and having abandoned the work, the Department assumed control, material was purchased in open market and work commenced April 24, 1892, with a force of 13 men, all told.

On June 29, 1892, the last construction work under the present appropriation was done, being the placing of 92.19 cubic yards of rock at the outer end of the south jetty. Quite a number of working days were lost during the time between April 24 and June 29, owing to high southeasterly winds and rough seas.

Twenty-eight 18-foot by 32-foot, one 18-foot by 18-foot, and two 12-foot by 32-foot mats were sunk, and one hundred and ninety-eight 32-foot fascines for crowning were put in the south jetty, extending it 528 feet more than was expected. This additional extension of the south jetty was due to the fact that the upper course of 12-foot by 32-foot mats to extend over the shoal a distance of about 1,000 feet, was dispensed with according to your instructions, the material thus saved from the upper course being used to extend the lower, and a crowning of fascines described above substituted.

The total length of the south jetty is 2,371 feet, of which the contractors put in 1,425 running feet of the lower course of 18-foot by 32-foot, 776 feet of the lower course for twenty-four 12-foot by 32-foot mats, and 208 running feet of four fascines on each mat for crowning. On top of the 1,425 feet of the south jetty there were placed by the contractors 479.22 cubic yards of stone, and an additional distribution of 350 cubic yards was subsequently placed over this portion to bring the top to an average height of 1 foot above mean low tide. On the 528-foot extension of the south jetty, and the 418 feet of mattress work to fill the gap over the old channel, a total of 360 cubic yards of stone was placed, making a total placed by the Department of 710 cubic yards. At the outer end of both jetties a larger quantity of stone was placed than at any other part of the work. This was done to secure the stability of the mats in case of scour around the ends.

Beacons.—On entering the new channel from the bay a red beacon is placed at the end of the south jetty and a black one at the end of the north jetty. These beacons are made of pine lumber 10 by 10 inches by 18 feet, and 4 by 4 inches by 25 feet, with balls 6 feet in diameter at the tops, and are thus erected: The 10 by 10 inches by 18 feet pieces with edges chamfered are hauled down by a watch tackle into the soft bottom; an iron water pipe 12 inches in diameter and 6 feet long is then slipped over the 10 by 10-inch piece and then sunk into the bottom about 2 feet, the space between the timber and iron being filled with cement to protect the timber from the teredo. To the 10 by 10 inches the 4 by 4 inches is bolted with two 16 by $\frac{3}{4}$ inch iron screw bolts, making a splice of 8 feet. On top of each 4 by 4 inches a ball is made of pieces of 1 by 3 inches, its centerpiece being 6 feet long, nailed on top of the 4 by 4 inches at right angles to each other, forming a sphere. The south jetty beacon was painted red and the north beacon black. A row of stakes 200 feet apart marks each side of the new channel.

Improvement to navigation.—Since the opening of the new channel vessels engaged in the bayou trade now take full loads, when heretofore their loading was governed entirely by the depth of water on the bar (3 feet at mean low tide), on which they have been detained from one to fourteen days. The following letter from Mr. F. C. Magee, master of the schooner *Dolphin*, states the advantages derived from the improvement made:

CEDAR BAYOU, TEX., *June 28, 1892.*

DEAR SIR: I take great pleasure in saying that the improvement made on Cedar Bayou Bar by your Department has resulted in giving us a free passage in and out of our bayou. Heretofore we have been from one to fourteen days on the bar. Before the jetties and dredging were begun we had to load our schooners according to the depth of water on the bar; now we take full loads. I am expressing sentiments of all the masters of vessels in the bayou trade.

I remain, yours truly,

F. C. MAGEE,
Master of the Schooner Dolphin.

Maj. CHAS. J. ALLEN,
U. S. Engineer.

At the inner and outer ends of the dredged channel an average depth of $4\frac{1}{2}$ feet at mean low tide can be carried, the approach to the outer end being 4 feet in depth and that of the inner $4\frac{1}{2}$ feet.

AMOUNT OF MATERIAL USED IN NORTH AND SOUTH JETTIES.

North jetty.—In the north jetty there were placed 217.25 cords of brush and 1,089.01 cubic yards of stone by contract.

South jetty.—In the south jetty there were placed 292.19 cords of brush and 479.22

cubic yards of stone by contract, and 324 cords of brush and 710 cubic yards of stone by the Government.

Very respectfully, your obedient servant,

R. B. TALFOR,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF CEDAR BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

[Compiled from information furnished by Messrs. E. McLean and W. O. Jefrey & Bro., of Cedar Bayou, Texas.]

Vessels using the bayou, 16; 10 sailing vessels, 4 barges, and 2 steam tugs Draft, 3 feet to 4 feet 6 inches; tonnage, 12 tons to 96 tons; trips made during the year, 1,080; total tonnage, 26,940 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Brick	15,000	$48,000	$9,900
Cotton	50	7,000	188
General merchandise	4,992	73,250	8,025
Total	20,042	128,250	18,113

Increase since last year, 792 tons.

Comparative statement of commercial statistics of Cedar Bayou, Texas, for the fiscal years ending June 30, 1891 and 1892.

	1891.	1892.
Vessels using the bayou ... No.	18	16
Maximum draft ... feet	3½	4½
Maximum tonnage ... tons	96	96
Trips made ... No.	....	1,080
Total tonnage ... tons	....	26,940
Freight transported ... do	19,250	20,042
Total value of freight	$108,250	128,250
Total freight charges	$18,612	18,113

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IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

The survey of Buffalo Bayou and Galveston Bay to Bolivar Channel, with a view to improvement, was made in the winter of 1870–'71, in accordance with the provisions of section 2 of the river and harbor act of Congress approved July 11, 1870. The report of this survey is published in the Annual Report of the Chief of Engineers for 1871.

An examination of the bayou from Simms Bayou to the mouth of White Oak Bayou at Houston was made in 1880 under section 2 of the river and harbor act approved June 14, 1880. The report upon this examination is published in the Annual Report of the Chief of Engineers for 1881.

It is estimated in this latter-named report that the cost of an improvement to give a channel 100 feet wide and 12 feet deep between the points named, by dredging and removal of snags and other obstructions, and including some necessary revetment, would be $385,299.75. Following this report was an appropriation of $25,000 by act approved March 3, 1881, for "improving Buffalo Bayou, Texas, to secure a channel of 100 feet."

A project in accordance with the terms of the appropriation and in consonance with the report was submitted April 25, 1881, and the subsequent appropriations have been applied in general furtherance of that project.

Buffalo Bayou is a tide-water stream emptying into San Jacinto River, about 25 miles below Houston, the San Jacinto emptying into Galveston Bay. White Oak and Simms bayous are tributaries to Buffalo Bayou, the former entering it at Houston and the latter at a point about 11 miles below Houston.

The object of the improvement is to secure a channel 12 feet deep and 100 feet wide, those being the dimensions contemplated for channel improvement in Galveston Bay, the aim being to admit seagoing ships to Houston. These dimensions of channel exist naturally in Buffalo Bayou and the San Jacinto below Simms Bayou, though it is reported that a small bar exists in San Jacinto River near Morgan Canal.

Morgan Canal is the name given to a channel excavated by the Buffalo Bayou Ship-Channel Company through Morgan Point, a peninsula at the mouth of San Jacinto River. In Galveston Bay, in prolongation of the canal, is Morgan Cut, also executed by the same company, connecting it with the ship channel dredged in the bay by the United States. The canal and cut now belong to the United States.

It is between White Oak and Simms bayous that improvement of Buffalo Bayou is almost entirely needed. The banks here are high and generally stable, though occasionally subject to landslides. The surface width is generally greater than 100 feet, though there are some exceptions to this rule. The depth in the middle of the channel is usually 9 feet or more at ordinary tides, but there are occasional shoals upon which as little as 5 or 6 feet are found, and during northers the water surface is sometimes lowered several feet. At some points navigation is obstructed by the sharpness of the bends. It is endangered also by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

The commerce of the bayou is important. It is mostly carried on by means of barges towed by tugs. The draft of the latter is 7 feet or less; that of the former, when fully loaded, about 5 feet.

Even if but partial improvement of the channel be made with the sums appropriated, so as to secure 9 or 10 feet of water at mean low tide, the resulting benefit will be not only immediate, but great, and this benefit will be increased by easement of bends and removal of snags, trees, etc. When a 12-foot depth is maintained throughout from Bolivar Channel to Morgans Cut and Canal, and through the latter to San Jacinto River, the depth of Buffalo Bayou can be correspondingly increased as appropriations are made.

A new supply of sunken logs is found annually in Buffalo Bayou, and considerable shoaling from surface wash also occurs annually.

Judging from the original estimate of the cost of the improvement, the sum already expended, and the annual contributions of snags, logs, and silt to the stream, it is reasonably certain that the amount esti-

mated for completion of the project, which has accompanied the annual reports upon the work for several years past, will not be sufficient for that purpose. To make a new estimate would involve a resurvey, which would cost $5,000; but that expenditure, in view of the importance of the improvement, would be well repaid. In the absence of more definite information, the estimate of the cost of the work as originally rendered, and which was undoubtedly correct at the time it was made, is retained in this report. It is $385,299.75.

The appropriation of $25,000 made by act of Congress August 11, 1888, was applied to dredging and removal of stumps and logs from bed and banks, between White Oak Bayou and a point 6 miles below, as stated in the Annual Report for 1890.

Congress by act of September 19, 1890, appropriated $25,000 for continuing the improvement, which sum was also applied to dredging, easing of bends, and to removal of stumps, logs, and overhanging trees. This work, which was done by contract, commenced March 1, 1891, and was completed September 7 following.

The work done up to the close of the fiscal year ending June 30, 1891, resulted in easing the sharpness of a number of bends and removing a large number of obstructions from the bed and banks of the bayou; and that done July, August, and September of the past fiscal year resulted in further easing the bends and in removing an additional number of obstructions.

For statement in detail of the work of the past year, reference is made to the accompanying report of Assistant Engineer R. B. Talfor.

The trade of the bayou is principally carried on by the Houston Direct Navigation Company with tugs and barges. A statement of the freight carried by them during the past fiscal year is appended. Many small vessels also visit the bayou. To ascertain the extent of this trade a special agent was employed throughout the year to keep a daily record of all such vessels. The shipments of cotton down the bayou from Houston to be loaded on to seagoing vessels at Galveston are immense. The number of tons thus shipped during the past fiscal year was 84,189, as against 81,548 for the year preceding.

While the appropriations thus far made from time to time for this improvement have aggregated but about 44 per cent of the originally estimated cost of the improvement, and while the work done under those appropriations has in consequence not secured the full depth or width of the channel required, the improvements thus far effected have so greatly facilitated navigation that further and regular appropriations for the improvement of this important stream can justly be asked for. In view of the probable increase in the commerce of Buffalo Bayou, some of those interested in its navigation favor an improved channel of greater dimensions than the present project provides for. The practicability and cost of such increased channel can only be decided by a full and complete survey.

Aggregate amount appropriated to July 1, 1892	$168,750.00
Expended under the project to July 1, 1891	155,700.36
Expended during the past fiscal year	10,103.63
Total expended under the project	165,803.99

It is proposed to apply the balance of funds, so far as it will go, in removing small obstructions, etc.

It is estimated that the sum of $50,000 can be profitably expended during the fiscal year ending June 30, 1894, in continuing the im-

provement by again going over the ground more or less where dredging has been done; in widening the waterway where the surface width is less than 100 feet and where the cost of widening is not excessive and where the banks will bear such widening without danger of sliding; in deepening the channel where its depth is less than 10 feet; in easing the bends, and in removal of logs, stumps, etc.

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1892, is $161,052.48.

Abstract of appropriations made by Congress for improving Buffalo Bayou, Texas.

By act approved March 3, 1881	$25,000
By act passed August 2, 1882	50,000
By act approved July 5, 1884	25,000
By act approved August 5, 1886	18,750
By act of August 11, 1888	25,000
By act approved September 19, 1890	25,000
Total	168,750

Money statement.

July 1, 1891, balance unexpended	$13,049.64
June 30, 1892, amount expended during fiscal year	10,103.63
July 1, 1892, balance unexpended	2,946.01
July 1, 1892, outstanding liabilities	30.00
July 1, 1892, balance available	2,916.01
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	27,916.01
Amount (estimated) required for completion of existing project	191,549.75
Amount that can be profitably expended in fiscal year ending June 30, 1894	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Texs., June 30, 1892.

SIR: I have the honor to submit the following report of operations for the improvement of Buffalo Bayou, Texas, for the fiscal year ending June 30, 1892:

At the date of my last annual report the work under that appropriation had not been completed. The work of improvement, however, was carried on until September 7, 1891, at which time the money available was expended. Between June 30 and September 7, 1891, the dredging plant was engaged in taking out the worst of the stumps and logs that were in the way of the improved navigation between Constitution Bend and the city of Houston, and also the removal of the point at Bend No. 4, the derrick being placed on the top of the bank and depositing the excavated material 80 feet from the water's edge. The removal of this point and the three points below has very materially aided the improved navigation of the bayou. The last work done was at the turning point at the foot of Main street, Houston, where the contractor took out about 1,500 cubic yards extra at his own expense after the appropriation was expended, so as to give better facility for the turning.

Reference was made in my last annual report to the dumping of garbarge, etc., on the banks of the bayou by privates parties and the city of Houston. These parties and the authorities of the city have been notified by you officially to discontinue the abuse. It is to be hoped that this nuisance will be abated, especially as

the growing importance of this waterway as a commercial outlet to Houston is increasing to such an extent that its future value can not be estimated.

Very respectfully, your obedient servant,

R. B. TALFOR,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

[Compiled from reports of Special Agents L. F. Allien, of Houston, Tex., and L. Megget, secretary Houston Direct Navigation Company.]

Vessels using the bayou.—Thirty-two barges, length, 65 feet to 162 feet; draft, 4 feet to 6 feet; tonnage, 23 to 358 tons. Eight steam tugs, length, 50 feet to 94 feet; draft, 4 feet to 6½ feet; tonnage, 12 tons to 105 tons. Three steamers, length, 57 feet to 145 feet; draft, 4 to 4½ feet; tonnage, 26 tons to 240 tons. Seventy-one schooners and sloops, length, 22 feet to 80 feet; draft, 2 feet to 6 feet; tonnage, 4 tons to 40 tons each. Trips made during the year, 3,345. Total tonnage, 398,452 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (336,654 bales)	84,189	$13,138,980	$153,485
Cotton seed, cake, and meal	21,750	430,477	19,967
Coal and wood	15,595	70,171	12,081
Lumber and shingles	1,533	16,650	3,873
General merchandise	9,112	134,372	17,313
Total	132,179	13,790,650	206,719

Increase since last year, 24,091 tons.

Comparative statement of commercial statistics of Buffalo Bayou, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, 1891, and 1892.

Year.	Vessels using bayou. Schooners.	Steamers.	Barges.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*No.*	*No.*	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	62	7	20	173	8	254	920	....
1889	38	7	19	173	7	254	735	....
1890	42	7	19	173	7	254	617	....
1891	33	4	31	162	6	358	2,274	295,869
1892	71	11	32	162	6½	358	3,345	398,452

Year.	Transported. Cotton.	Cotton-seed cake.	Wood and coal.	Lumber and shingles.	Iron and steel.	General merchandise.	Total weight.	Total value.	Total freight charges.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	26,692	9,959	4,320	2,765	1,509	4,596	49,841	$5,132,328	$94,960
1889	41,227	12,628	3,456	1,221	1,120	898	60,550	7,617,380	98,794
1890	66,852	19,199	2,970	512	1,278	5,423	96,234	13,880,766	154,715
1891	81,548	12,469	9,810	622	....	3,639	108,088	16,243,895	156,906
1892	84,189	21,750	15,595	1,538	....	9,112	132,179	13,790,650	206,719

U 6.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The work of construction for improvement of this harbor was suspended in October, 1884. The subject of improvement of the harbor was referred by the Chief of Engineers, under date of December 8, 1885, to the Board of Engineers for report. The Board called for certain information which involved a resurvey of the harbor and other investigations. A surveying party left Galveston on the 24th of June, 1887, to procure the desired information, completing the survey early in August following. The results of the survey were reported under date of September 29, 1887. The report showed that the work (south jetty) completed in 1884 had practically disappeared. The project under which that jetty had been built contemplated the construction of two parallel jetties, as follows: The south jetty (Brazos Island Jetty) to be 3,630 feet long and the north jetty (Padre Island Jetty) to be 2,940 feet; the direction of the jetties to be in prolongation of the pass, the width between them to be about the same as that of the narrowest part of the pass, viz, 1,500 feet; estimated cost of the north jetty, about $130,000; estimated cost of the south jetty about $190,000. In addition it had been proposed to construct a dam from Point Isabel to Brazos Island to increase the depth of water on the bar and in the channel to Point Isabel by preventing the flow towards Boca Chica. Approval had been given to so much of the project as covered the construction of the south jetty. For information in detail as to the condition of the work and cost of further improvement, reference is here made to the report of September 29, 1887, and to that of the Board of Engineers, both contained in Appendix T to the Annual Report of the Chief of Engineers for 1888, pages 1322–1330 and pages 1299 and 1300.

From the best information attained by the survey the cost of an improvement to consist of two parallel jetties placed about 1,100 feet apart was estimated at not less than $1,130,000, and it was also estimated, in the Annual Report for 1888, that the appropriation necessary for carrying on that work (should it be ordered) for the fiscal year ending June 30, 1890, should not be less than $600,000. The total of expenditures under appropriations at the date of rendering the estimate of $1,130,000 was $188,590.23, so that the revised estimate of cost of the improvement, counting from the commencement of the work, was thus brought up to $1,318,590.23.

The total of appropriations to include the last one, that of $25,000, by act of August 11, 1888, is $247,500. The expenditures since work ceased in 1884 have amounted to $5,134.87 in making survey and in contingencies, including in the latter the cost of collecting commercial statistics of the port.

No work for improvement was done during the past fiscal year, the amount of money available having been too small to warrant commencing it. A special agent was employed during the year to keep a daily record of all incoming and outgoing trade. Commercial statistics compiled from this record are hereto appended. It will be seen that the trade of the port is comparatively light. Comparison of this with records of last year shows a decrease of tonnage of 4,149 tons.

The conclusion that not less than $600,000 should be available before undertaking further work is here concurred in, though it is not asserted that the amount of commerce to be benefited justifies such an expenditure at this time. And it is respectfully suggested that if the importance of the port be not considered sufficient to justify so large an

appropriation the improvement be deferred for the present. There remain in round numbers $542,000 as the sum that should be appropriated for the fiscal year ending June 30, 1894, in case Congress orders the improvement indicated.

Original estimated cost of the work as revised in 1888	$1,318,590.22
Aggregate amount appropriated to July 1, 1892	247,500.00
Amount expended to July 1, 1891	189,608.59
Amount expended during the past fiscal year	190.00
Total expended to July 1, 1882	189,798.59

In addition there was appropriated in 1878 $6,000, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest light house is the Brazos Santiago light-house, on Padre Island. The amount of revenue collected at the port of Brownsville during the fiscal year ending June 30, 1892, was $1,692.68.

Abstract of appropriations made by Congress for improving harbor at Brazos Santiago, Tex.

By act approved—	
June 14, 1880	$25,000
March 3, 1881	75,000
By act passed August 2, 1882	60,000
By act approved—	
July 5, 1884	25,000
August 5, 1886	37,500
By act of August 11, 1888	25,000
Total	247,500

Money statement.

July 1, 1891, balance unexpended	$57,891.41
June 30, 1892, amount expended during fiscal year	190.00
July 1, 1892, balance unexpended	57,701.41
July 1, 1892, outstanding liabilities	15.00
July 1, 1892, balance available	57,686.41
Amount (estimated) required for completion of existing project	1,071,090.22
Amount that can be profitably expended in fiscal year ending June 30, 1894	543,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

[Compiled from reports rendered by Special Agent E. J. Kenedy, of Isabel, Tex.]

Vessels using the harbor, 15; 3 steamers and 12 sailing vessels. Length on deck, 60 feet to 220 feet; draft, 3 feet 2 inches to 9 feet 4 inches. Tonnage, 31 tons to 717 tons. Trips made during the year, 127. Total tonnage, 48,724 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Wool and hides	3,092	$154,600	$24,225
Lumber	1,865	23,166	8,932
General merchandise	12,538	669,180	132,695
Total	17,495	846,946	165,852

Decrease since last year, 4,149 tons.

Comparative statement of commercial statistics of Brazos Santiago Harbor, Tex., for the fiscal years ending June 30, 1888, 1889, 1890, 1891, and 1892.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536
1892	15	220	9.4	717	127	48,724

Year.	Transported.					Total value.	Total freight charges.
	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.		
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	....	2,925	2,324	9,867	15,166	$737,432	$83,541
1889	130	3,080	3,188	10,885	17,283	820,315	78,140
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,132
1891	....	3,218	2,434	15,992	21,644	1,061,082	160,215
1892	....	3,092	1,865	12,538	17,495	846,946	165,852

Revenue collected.

1888	$31,625.00
1889	20,338.00
1890	37,990.00
1891	8,386.32
1892	1,692.68

U 7.

PRELIMINARY EXAMINATION OF BRAZOS RIVER, TEXAS, FROM ITS MOUTH TO WACO.

[Printed in House Ex. Doc. No. 63, Fifty-second Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 20, 1891.

SIR: I have the honor to submit herewith copy of reports, dated February 24 and October 1, 1891, by Maj. Charles J. Allen, Corps of Engineers, on preliminary examination of Brazos River, Texas, from its mouth to Waco, made in compliance with provisions of river and harbor act approved September 19, 1890.

It is the opinion of Maj. Allen and of the Division Engineer, Col. C. B. Comstock, Corps of Engineers, that this locality is not worthy of improvement by the United States. I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 24, 1891.

GENERAL: I have the honor to report as follows regarding a preliminary examination of Brazos River from its mouth to Waco, in compliance with sections 17 and 18 of the river and harbor act of Congress approved September 19, 1890.

A survey of Brazos River from Waco to the mouth was made in 1874 in accordance with the requirement of act of Congress of June 23 of that year. The report of that survey is printed in the Annual Report of the Chief of Engineers for 1875, part 1, pages 929–941.

From that report it is seen that the distance from Waco to the mouth is, following the channel, 430 miles. At the time of the survey the river, within the limits named, contained upward of 140 shoals and bars upon which the depths at low water were from 1 to 12 inches, the shoals or bars averaging 60 to 3,000 feet in length and being composed mostly of rock and bowlders. In addition the river was encumbered, more or less, with snags.

As early as 1832 the river sustained considerable commerce, which increased in importance until 1858. During that time, high-water navigation extended to Washington, 255 miles above the mouth of the river, and the low-water navigation to Columbia, 36 miles above the same point. The mouth of the river was obstructed by a bar upon which the depth of water varied.

About 1858 inland water navigation was secured between Brazos River and Galveston by the opening, by private parties, of a canal which obviated the necessity of small vessels making the outside passage.

In 1857–'58 the State of Texas undertook improvement of the river from Washington to its mouth, $60,000, as reported, having been appropriated for that purpose. Some improvement of the rock shoals was effected, and some snags were removed from the lower river, but there was, as reported, general complaint of the insufficiency of the work.

Shortly after 1858 the city of Houston began to tap the trade of the upper Brazos country, and by 1875 it had drawn it away from the river above Columbia. In 1875 two small steamboats running to Columbia represented the entire commerce of the river.

The present commerce of the river is carried on by one small steamboat running from Galveston, via West Galveston Bay and the Brazos Canal, to Columbia, and to Bolivar Landing, 18 miles above Columbia, depending upon the stage of water in Brazos River, and, as reported, by a number of sloops and schooners that navigate the river from its mouth to Bolivar Landing during the cotton and sugar season, stage of water permitting.

It has been stated that the value of the traffic through West Galveston Bay, in one season, from Brazos River alone, amounted to $732,000, but the particular year was not given.

In Appendix T to the Annual Report of the Chief of Engineers for 1888, the total value of the trade of the river for the fiscal year ending June 30, 1888, was stated, approximately, as $136,408, viz:

Via mouth of river	$48,344
Via canal	88,064

There is a life-saving station on Galveston Island, about 17 miles from the mouth of the Brazos. The nearest light-house is at the entrance to Galveston Harbor.

The work of improving the bar at the mouth of the river is in the hands of a private corporation, authorized to make that improvement at its own expense.

Improvement of the Brazos, from Waco to its mouth by private parties has been contemplated very lately, as appears from the following extract from a printed pamphlet, entitled "Report of a Preliminary Survey of the Brazos River, made by Prof. J. H. Hurwood, for the Waco Board of Trade, July and August, 1890:"

EXTRACT.

The Waco Board of Trade, early in the month of June of this year, was urged to give attention to the subject of the Brazos River, to ascertain if possible whether that river is susceptible to navigation. At a meeting held June 6 Judge J. N. Lyle, a most ardent advocate of such movement, presented the following preamble and resolution:

"Whereas it is deemed practicable to so improve the channel of the Brazos River as to render it navigable for a greater part of the year from Waco to its mouth; and

"Whereas the desired work of improvement can be more rapidly and economically accomplished by private enterprise, organized after the manner of the syndicate now improving the mouth of the Brazos, with rights and privileges conferred by act of Congress: Therefore,

"*Resolved*, That the president of the Waco Board of Trade appoint a committee of five, whose duty it shall be to concert measures looking to the organization of, and, if practicable, to organize a syndicate to secure such legislation as may be necessary and start the work of improvement aforesaid; and said committee is hereby authorized to visit and confer with the officers of the syndicate now improving the mouth of the Brazos, and endeavor to enlist their coöperation in the enterprise."

As soon as the high water in the river subsided sufficiently I had a reconnoissance made from its mouth to Bolivar Landing in order to obtain the latest information in regard to obstructions to navigation on that portion of the stream. The reconnoissance was made by R. B. Talfor, assistant engineer. From the report of that reconnoissance (copy herewith) it appears that there are about 200 snags and trees in the bed of the river below Bolivar Landing, about 150 of which are obstructions to navigation and scattered along a distance of about 40 miles. It does not appear from all that I have been able to learn that these obstructions are so formidable as to prevent the use of the river by the steamboat and other vessels mentioned when the stage of water is sufficiently high for them to navigate it.

To overcome the obstructions to low-water navigation presented by the rock and bowlder shoals a system of locks and dams would be required, the cost of which would be out of all proportion to the present commerce of the river. As for the prospective commerce of the stream, or that which might be developed by an expensive improvement, the present indications are too vague and uncertain for them to bear in any degree upon the question of improvement.

Taking into consideration all the foregoing, I am unable to discover any good reason why the United States Government should undertake an improvement of the Brazos River.

I am, therefore, of opinion that this river should not now be classed amongst those worthy of improvement by the General Government.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, March 2, 1891.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion of the district officer that Brazos River is not at present worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A., Division Engineer.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., February 19, 1891.

SIR: I have the honor to report on the examination of the Brazos River from its mouth to Bolivar Landing, 18 miles above Columbia, made February 14, 15, and 16.

This examination shows that there are about 200 snags and trees in the bed of the river, mostly of live oak, with a few cottonwood, elms, and willows. Of this number 150 are obstructions to navigation and are scattered over a length of the river embraced between a point 14 miles above its mouth and Bolivar Landing, a distance of about 40 miles, and are located as follows:

	Snags.
From the mouth to Brazoria	20
From Brazoria to Columbia	69
From Columbia to Bolivar Landing	54
Total snags that impede navigation	143

About 6 miles above the mouth of the river an obstruction of white oak logs was placed during the late war to prevent the passage of Union gunboats; this has been partially removed, but does not interfere with the present navigation.

Two steamboat wrecks were found—one near the landing at Brazoria, the other 3¼ miles above.

The commerce of the lower Brazos consists of sugar, cotton, molasses, hides, cottonseed, corn, etc., and is mostly carried by steamboat to Galveston, although there are a number of sloops and schooners engaged in the river trade during the cotton and sugar season.

In conclusion would state that I am indebted to Messrs. Branch Masterson, Travis Smith, and also Captain Keen, of the steamboat *Whitewater*, for assistance and information received.

Very respectfully, your obedient servant,

R. B. TALFOR,
Assistant Engineer.

Maj. C. J. ALLEN,
Corps of Engineers, U. S. A.

SUPPLEMENTARY REPORT.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 1, 1891.

GENERAL: In compliance with indorsement, Office Chief of Engineers, August 31, 1891, upon my letter of August 27, I caused a further examination to be made of the lower Brazos River, with the view of ascertaining the present extent of its navigation and prospective increase in commerce. The examination was made by Lieut. William C. Langfitt, Corps of Engineers, a copy of whose report upon the same, and to which attention is invited, is herewith.

As stated in my letter of August 27, there appeared to have been a large increase in the number of steamers navigating the lower river. The inference as to this increase had been drawn mostly from advertising and other statements, and it was with a view to avoid injustice to the navigation and commerce of the stream that the supplementary examination was suggested. The report of the late examination mentions six steamers in addition to the one reported under date of February 24, and as follows:

The following steamers are now found on the river, viz: *Whitewater*, *Chrystie*, *Justine*, *Emily P.*, *Orlina*, *Steadman*, and *Alice Blair*. The *Whitewater* and *Emily P.* are small-sized, ordinary stern-wheel river boats. The latter plies only between Velasco and Galveston, making three round trips each week. The *Whitewater* makes one round trip each week between Galveston and Columbia. When notified she ascends the river as far as Bolivar for freight and is the only one that does so. The *Chrystie* is a small screw steamer about 30 feet long, carrying the mail and express from Columbia (present terminus of railroad) to points down the river. She is limited to twenty-five passengers and can carry but little freight. She makes one round trip daily between Quintana and Columbia. The *Justine* is a trifle larger boat, but similar to the *Chrystie* and is at present undergoing repairs. When these are completed she will replace the *Chrystie*, which will then run between Velasco and Galveston, three round trips per week. These four steamers belong to the Columbia Transportation Company. The *Orlina* and *Steadman* are small boats like the *Chrystie*, are limited to twenty-five passengers each, and ply between Velasco and Quintana, carrying passengers back and forth. The distance is about 4 miles. The *Alice Blair* is a good-sized stern-wheel river steamer, plying between Velasco and Columbia and making one round trip per day. She carries considerable freight and most of the passengers for Velasco brought into Columbia by the railroad, but the early completion of the Brazos and Northern Railroad from Velasco to Chenango will take this trade. She is at present connected with the management of the Brazos River Channel and Dock Company, and I understand that upon completion of the railroad she will either be taken off of the river altogether or become a freight boat in competition with the boats of the Columbia Transportation Company.

In this condition of affairs it is evident that the freight carried by the *Whitewater* is all that properly belongs to that portion of the river under consideration.

Following are channel distances from the original mouth of the river of points mentioned in the preceding quotation:

Quintana, at mouth of river.

Velasco, 5 miles above mouth of river.

Columbia, 37 miles above mouth of river.

Brazoria and Bolivar, other points mentioned in Lieutenant Langfitt's report, are, respectively, about 29 and 49 miles above the mouth.

The situation on the lower Brazos may be summed up about as follows:

The improvement of the mouth of the river is in the hands of a private corporation under an act of Congress, August, 1888, said act authorizing the corporation to charge and collect tolls under regulations that may be made by the Secretary of the Treasury of the United States. This company has made extensive improvements at the mouth of the river and the bar by construction of jetties extending about 6,000 feet into the Gulf of Mexico, and has extended its work of channel improvement up to Velasco, and it is understood that the same company expects to carry the improvement about 7 miles farther upstream.

Brazos River is connected with West Galveston Bay by a canal owned by a private corporation, the Columbia Transportation Company, which has the right to exact tolls from vessels using it. The entrance to this canal from Brazos River is about three-quarters of a mile from the river mouth.

Produce in vessels therefore seeking the Gulf of Mexico from the river, and *vice versa*, must pass through channels controlled by private parties.

My report of February 24, last, referred to resolutions by the Waco

Board of Trade looking to the organization of a syndicate to undertake improvement of the river more or less from its mouth to Waco.

It does not appear that there has been any material increase in shipment of farm products by river over what was reported three years ago. I see no reason, therefore, to change the opinion expressed in my report of February 24, last, that this river should not, at present, be classed amongst those worthy of improvement by the General Government.

The foregoing report does not take into consideration the ocean vessels arriving at and departing from Velasco, as they traverse that part of the river under improvement by the private corporation mentioned above.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUT. WM. C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., September 30, 1891.

MAJOR: I have the honor to submit the following report of an examination of the Brazos River, Texas, from its mouth to Bolivar for the purpose of obtaining some idea of its need of improvement, together with such statistics as to the present and prospective value of its commerce as could be obtained.

As it was impossible to view the river by boat from Bolivar to Columbia (there being no boat going either way for at least a week after the date of my visit) I left the train for Columbia at Oyster Creek Station and stayed over night with the owners of one of the most productive plantations on the river between Bolivar and Columbia. Through their kindness I was enabled to view the river over a stretch of 2 or 3 miles, beginning at a point about 2 miles below Bolivar and going downstream. From Columbia down I took the *Chrystie*, a small screw steamer.

For the purposes of this report I will divide the river into three parts, viz: (1) That portion between its mouth and the town of Brazoria; (2) that portion between Brazoria and Columbia; (3) that portion between Columbia and Bolivar and points farther up.

It may be well to state here that the principal complaint made by boatmen is about the snags and sunken logs that render navigation dangerous. The depth is or would be everywhere sufficient if the snags and sunken logs were removed. The shoalest water between the mouth and Columbia is claimed to be at a point about 3 miles below the town of Columbia on a shoal extending across the river, upon which, it is stated, there is 8 or 9 feet of water. It consists, I am told, of a stratum of hard clay which crops out in the bed of the river. But for this shoal, I was informed, 12 feet of water could be carried to Columbia. From Columbia up to Bolivar the depth is stated at from 10 to 12 feet. Above Bolivar the river has occasional shoals, caused, it is claimed, by sunken trees blocking the stream, and the river men think that should these be removed the depth would everywhere be sufficient at ordinary low water for the ordinary river steamers as far as the Gulf, Colorado and Santa Fé Railroad bridge near Richmond, where navigation would be obstructed by said bridge, which is without drawspan. Some of the residents along the river claim that navigation could be carried to Washington, 225 miles from the mouth, by simply clearing the river of snags, provided the bridges crossing the stream were provided with draws. I understand that private parties have taken some steps looking towards the improvement of the river from Waco down at least as far as Richmond.

I will now take up the three divisions of the river in turn:

(1) Between the mouth and Brazoria, a distance of about 28 miles, there were, perhaps, some fifty snags visible in the river which might, under a large or night traffic, be dangerous but which at present are easily avoided. Most of these snags are situated in the first few miles below Brazoria. Of this portion of the river, I was informed by a representative of that company, that the Brazos River Channel and Dock Company proposed to control the lower 12 or 14 miles and put in such wing dams, revetments, etc., and make such cut-offs as they deemed necessary.

(2) Between Brazoria and Columbia, a distance of about 9 miles, the snags are much more numerous. There are four or five places where these obstructions reduce materially the width that would otherwise be available by from one-third to one-half. It is difficult to estimate the number of snags in this portion of the river without a survey made for that purpose. I counted over forty in a space of 2 miles, and was informed by the captain of the steamer that there were many dangerous ones not visible. Just below the landing at Brazoria there is a sunken steamer.

(3) From Brazoria to Bolivar and beyond the snags are still more numerous, and on account of the decreasing width of river are increasingly dangerous. Night navigation is never carried on in this portion of the river.

The river near the new town of Velasco is from 500 to 600 feet in width, at Columbia from 250 to 300 feet, and near Bolivar about 200 feet in width.

Overhanging trees in any portion of the river do not as a rule impede navigation. They are simply undesirable from the fact that when they are growing on the caving bank their weight helps to break it down and they then become snags. As to their number it was impossible for me to make any estimate, but it may be stated generally that they occupied every caving bank from below Brazoria up, and are exceedingly numerous. Most of the dangerous snags come from live-oak trees which, in the fresh water, last almost indefinitely.

Finally I am of the opinion that no estimate of the cost of improvement can be made with any correctness without a survey made for that purpose.

I found it extremely difficult to obtain any data from which an estimate could be made of the commerce now existing on the river and that to be expected in the future. The following steamers are now found on the river, viz: *Whitewater*, *Chrystie*, *Justine*, *Emily P.*, *Orlina*, *Steadman*, and *Alice Blair*.

The *Whitewater* and *Emily P.* are small-sized, ordinary stern-wheel river boats. The latter plies only between Velasco and Galveston, making three round trips each week. The *Whitewater* makes one round trip each week between Galveston and Columbia. When notified she ascends the river as far as Bolivar for freight and is the only one that does so. The *Chrystie* is a small screw steamer, about 30 feet long, carrying mail and express from Columbia (present terminus of railroad) to points down the river. She is limited to twenty-five passengers, and can carry but little freight. She makes one round trip daily between Quintana and Columbia. The *Justine* is a trifle larger boat, but similar to the *Chrystie*, and is at present undergoing repairs. When these are completed she will replace the *Chrystie*, which will then run between Velasco and Galveston three round trips per week. These four steamers belong to the Columbia Transportation Company. The *Orlina* and *Steadman* are small boats like the *Chrystie*, are limited to twenty-five passengers each, and ply between Velasco and Quintana, carrying passengers back and forth. The distance is about 4 miles. The *Alice Blair* is a good-sized stern-wheel river steamer, plying between Velasco and Columbia and making one round trip per day. She carries considerable freight, and most of the passengers for Velasco brought into Columbia by the railroad, but the early completion of the Brazos and Northern Railroad from Velasco to Chenango will take this trade. She is at present connected with the management of the Brazos River Channel and Dock Company, and I understand that upon completion of the railroad she will either be taken off of the river altogether or become a freight boat in competition with the boats of the Columbia Transportation Company.

In this condition of affairs it is evident that the freight carried by the *Whitewater* is all that properly belongs to that portion of the river under consideration. Mr. Smith, the manager of the Columbia Transportation Company, could not give, at the time, the value and articles composing it, of the freight collected along the river from Brazoria to Bolivar, beyond which latter point the boat has not in late years ascended. He promised, however, to consult his books, and mail on the 28th instant a letter giving these facts. As this letter has not arrived, and will perhaps not arrive in time to be of use to you, I submit the following estimate, based on conversations I had with various parties, of the value of the cotton and cotton seed raised on the lands tributary to the river from Brazoria to Bolivar, viz.:

4,100 bales of cotton, at $40 per bale	$164,000
1,400 tons of cotton seed, at $6.50 per ton	9,100
Total value	173,100

A small amount of this cotton goes by rail to Houston, and a considerable part of the cotton seed is not sent to market. Cotton is the main if not the only crop raised for market along the river below Bolivar. Above this point there are, I was told, sugar plantations cultivated. These articles are, of course, distributed in their delivery throughout the cotton season, and as a consequence are now handled by the one steamer. I have no means of estimating the value of the return freight, consisting of supplies for the planters along the river and for the towns of Brazoria and Columbia. It can not at present amount to any very large figure. Passing to the pros-

pective commerce of the river from above Brazoria, nothing of any definite nature could be obtained. It was generally believed, however, that a great development of the country was to be expected in the near future. At present less than three-fourths of the available land is cultivated. The planters believe that emigration will now be turned in their direction, and that the present large, unwieldy holdings will be divided up with a consequent gain in productiveness, and that, should the town of Velasco become a shipping port of magnitude, these results will be hastened, but in any case they believe that all the fertile bottom lands of the Brazos River, Oyster Creek, and Bernard River will be cleared and cultivated in the next few years. In doing this a valuable lumber trade must spring up in live oak, ash, and elm timber, which at present covers so large a portion of the bottom lands. They further believe that the prairie lands beyond the timber belt will be cultivated for cotton, fruits, corn, etc., the bottom lands being reserved for sugar cane. The products of all these lands, it is thought, will be shipped largely by the river, and that the boats on the latter will, by their competition with each other and with the railroad, keep freights low. Some of the more sanguine believe that, should Velasco become a large seaport, a large trade would spring up along the river as far as Washington, were the obstructions removed that far.

In the lack of more definite data I am compelled therefore to simply state, as a summary, that the parties most interested in the improvement of the river believe that a large and valuable trade will spring up in the future, but that before this can do so the river must be opened up by the removal of the snags and shoals that now obstruct it, and that the clearing up of the river at this time will facilitate the development of trade and attract emigration and capital by offering a cheap and regular communication with the outside world.

It is undoubtedly the case that, should a considerable commerce develop above Brazoria, it would be greatly hindered by these obstructions, and their removal would be a proper work to be undertaken. But at present the proposed seaport of Velasco is but a new town of two months' growth without, at present, facilities for accommodating a sea traffic. A wharf, however, is now being built, and the Brazos and Northern Railroad will, it is said, be completed in November. But it is evident that no increase of traffic of any amount can be expected on the upper river for this season at least, the crop having already been made. Again, the banks of the river being alluvial and very easily eroded, effects of works done at one point may be felt long distances above or below, depending on the character of the work. The Brazos River Channel and Dock Company claim the right to control the river for a distance of 12 or 14 miles from its mouth, and it is their intention to make at least two cut-offs in that distance. Should the General Government undertake the improvement of the river above the point claimed by the company, it is possible that its work might be largely increased in consequence of operations carried out by the company. Further, should private parties undertake the improvement of the river from Waco to Richmond, the work of the General Government might, from the effects of their work, be again injured or rendered of no effect.

Considering all the circumstances of the case, it would seem that for the present at least no action by the General Government is to be recommended.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut., Corps of Engineers.

POSTSCRIPT.—In order to avoid misunderstanding it may be well to state that, in speaking of the commerce of the river, I have not included the seagoing vessels which enter the river between the jetties and stop at Velasco, and which have heretofore been laden mainly with materials for the works of the Brazos River Channel and Dock Company, which company has constructed the jetties, and propose to control the river for a distance of at least 12 miles from its mouth.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

U 8.

[Printed in House Ex. Doc. No. 22, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF WEST GALVESTON BAY, TEXAS, FROM CHRISTMAS (CHRISTIANS) POINT, WITH A VIEW OF REOPENING THE CHANNEL THROUGH WEST BAY.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 12, 1890.

GENERAL: I have the honor to submit the following report of a preliminary examination of "West Galveston Bay, from Christians Point, with a view of reopening the channel through West Bay," made in compliance with the requirements of sections 17 and 18 of the river and harbor act of Congress approved September 19, 1890.

West Bay is an expanse of water between Galveston Island and the mainland, and extending from Galveston Bay to San Luis Pass. Between West Bay and Bastrop and Oyster bays is Mud Island. (Please see United States Coast Survey Chart No. 105.)

The point of land between Oyster and Bastrop bays is noted on that chart as Christmas Point, though it is sometimes called Christians Point.

Oyster Bay is connected with the Brazos River by a canal executed by a private corporation. This canal, I am informed, is now undergoing deepening to maintain a 5-foot depth of water.

An examination of West Galveston Bay was made in November last under my direction by Mr. R. B. Talfor, assistant engineer. The following, quoted from his report of the examination, shows the present condition of the channel and, approximately, the extent of obstruction to a 5-foot navigation:

In accordance with the above instructions I left Galveston at 8:30 a. m. of the 27th with the schooner *Andrew Boden* for Christmas Point, via West Galveston Bay. The first obstruction to a 5-foot navigation was encountered at the Deer Islands, where but 3 feet was found in the steamboat channel, the tide at the time, 10 a. m., 27th instant, being approximately about three-fourths of a foot below mean low tide, with a bottom width of from 50 feet to 100 feet (approximately) for a distance of about one-half a mile. Second obstruction was found at Caronkaway Reef, 7 miles southwest of the Deer Islands, over which 3¼ feet was the least depth found. The present steamboat channel is about three-fourths of a mile to the northward of the old dredged cut which was filled up by the cyclone of 1875. The present channel through the reef is quite lumpy for a distance of about three-fourths of a mile, with about 3 feet of water on the lump at mean low tide. Third obstruction is at Shell Island, which lies about three-fourths of a mile southwest of Caronkaway Reef, on which is about 3 feet of water at mean low tide; length of shoal about one-fourth mile. Fourth obstruction is about 1¼ miles north of San Luis Pass, on which was found 4 feet of water (12 m., 27th instant), tide approximately at mean low; length of shoal about one-half mile. Fifth obstruction is in Oyster Bay, about three-fourths of a mile to the southwest of Christmas Point, where the channel last dredged makes a sharp angle with the general line of the cut (see chart). Three feet was the shoalest depth found at this point, its length from 5-foot contour to 5-foot contour being about one-half mile.

It appears from paper (copy herewith) received from Mr. Branch T. Masterson, of Galveston, that the State of Texas in 1859 had a channel dredged across Deer Island, Shell, Carancahua (Caronkaway), and Christian Point reefs, and that the channel remained open sixteen years until its depth and width were reduced by the cyclone of 1875. Also, that this channel, when open, furnished an outlet to market for the crops of Brazoria County, which now has a population of 11,000, as well as of the most thickly settled part of Matagorda County and the lower part of Fort Bend County; in fact, for all freight tributary to Brazos River and Chocolate and Bastrop bayous and Oyster Creek. That the partial closing of the channel by the cyclone of 1875 forces a large part of the traffic to be carried on by hauling to the river and by boating to Columbia, about 40 miles above the mouth of the river, thence by railroad to Houston and Galveston, causing loss of time and additional expense to farmers in shipping their produce to market. That notwithstanding the delay in waiting for high tides to enable crossing the reefs, one steamboat brings to market large quantities of cotton and that it carries in return cargoes of merchandise. That a great deal of freight is also carried by sail vessels in the open Gulf by selecting times when the Gulf is sufficiently calm to take the risk, though insurance companies have declined to insure cargoes by the open Gulf route as being too hazardous for regular navigation by light-draft bay and river sail vessels or steamers. And that the reopening of the channel through the reefs will increase safety and speed in navigation and develop a constantly increasing trade.

From a statement also made by Mr. Masterson, December 6 (copy herewith), it appears that the value of the traffic through West Bay in one season from Brazos River alone amounted to $732,000. In that statement it is also claimed that one steamboat from the Brazos River (by this route) running constantly reduced freight charges 50 per cent.

It would appear from the report and statistics that the channel through West Galveston Bay to Christians (Christmas) Point is worthy of improvement by the General Government, provided the cost of such be not disproportionate to the extent of the traffic as stated.

The expense of a full survey from which to determine the practicability and cost of such improvement is estimated at $3,000.

Appended hereto are an extract from the report of Mr. Talfor and copies of statements by Mr. Masterson.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 22, 1890.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion of the local engineer that this route is worthy of improvement. To what extent depends on the cost, which can only be determined by a survey.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 29, 1890.

SIR: I have the honor to report on a preliminary examination of the channels through West Galveston Bay to Christmas Point, per your letter of instructions on the 26th instant. In accordance with the above instructions, I left Galveston at 8:30 a. m. of the 27th with the schooner *Andrew Boden* for Christmas Point via West Galveston Bay. The first obstruction to a 5-foot navigation was encountered at the Deer Islands, where but 3 feet was found in the steamboat channel, the tide at the time, 10 a. m., 27th instant, being approximately about three-fourths of a foot below mean low tide, with a bottom width of from 50 feet to 100 feet wide (approximately) for a distance of about one-half a mile. Second obstruction was found at Caronkaway Reef, 7 miles southwest of the Deer Islands, over which 3¼ feet was the least depth found. The present steamboat channel is about three-fourths of a mile to the northward of the old dredged cut which was filled up by the cyclone of 1875. The present channel through the reef is quite lumpy for a distance of about three-fourths of a mile, with about 3 feet of water on the lump at mean low tide. Third obstruction is at Shell Island, which lies about three-fourths of a mile southwest of Caronkaway Reef, on which is about 3 feet of water at mean low tide; length of shoal about one-fourth mile. Fourth obstruction is about 1½ miles north of San Luis Pass, on which was found 4 feet of water (12 m., 27th instant), tide approximately at mean low; length of shoal about one-half mile. Fifth obstruction is in Oyster Bay, about three-fourths of a mile to the southwest of Christmas Point, where the channel last dredged makes a sharp angle with the general line of the cut (see chart). Three feet was the shoalest depth found at this point, its length from 5-foot contour to 5-foot contour being about one-half a mile.

In connection with the above, I would respectfully refer to the fact that if the channels through the reefs were staked off with beacons similar to the one at Hannas Island in Galveston Bay, the present navigation would be greatly benefited thereby.

3 beacons at Deer Island.
3 beacons at Caronkaway Reef.
2 beacons at Shell Island.
2 beacons at San Luis Pass.
4 beacons at Christmas Point.

* * * * * * *

CHARACTER OF BOTTOMS.

At Deer Island, shell and mud; at Caronkaway, shell and mud; at San Luis Pass, sand; at Christmas Point, soft mud in channel, stiffer mud on sides of cut.

Attached herewith are commercial statistics furnished by Mr. Branch Masterson.

Very respectfully, your obedient servant,

R. B. TALFOR,
United States Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

STATEMENT FURNISHED BY MR. BRANCH T. MASTERSON, NOVEMBER 6, 1890.

In 1859 the State of Texas had a channel dredged across Deer Island Reef, Shell Reef, Carancahua Reef, and Christian Point Reef, the balance of the entire distance through West Galveston Bay gives open water navigation for vessels drawing not exceeding 5 feet. This channel remained open until the cyclone of 1875, sixteen years, without a dollar's expense, and was constantly used. That cyclone by violent force of the water filled in the channel on the sides with sand and small shells until it became only from 2½ to 3 feet at low tide, and too narrow to pass through except at full tide. When this channel was open it furnished the outlet to market for the crops of Brazoria County, which now has a population of over 11,000 people, as well as the most thickly settled part of Matagorda and lower part of Fort Bend County, in fact all freight tributary to Brazos River and Chocolate and Bastrop bayous and Oyster Creek.

The trade kept two steamboats with carrying capacity of 500 bales of cotton each constantly employed, and numerous sail vessels and trading boats. The partial clos-

ing of the channel forces a large part of the traffic to be carried on by hauling to the river, boating to Columbia, about 40 miles from the mouth of the river, and thence to be hauled by railroad up to Houston and down to Galveston, causing loss of time and additional expense for farmers to get their freight or ship their products to market. Notwithstanding the delay of waiting for high tides to cross these reefs, one steamboat has brought to market over this route ——— thousand bales of cotton from September 1, 1889, to May 1, 1890, and carrying returning cargoes of merchandise, and a large part of the freight was brought by sail vessels in the open Gulf by selecting times when the Gulf was sufficiently calm to take the risk. Insurance companies have declined to insure cargoes by the open Gulf route as being too hazardous for regular navigation by light-draft bay and river sail vessels or steamers.

The reopening of the channel through the reefs will increase the safety and speed in navigation and develop a constantly increasing trade. This would require at Deer Island Reef dredging from 1 to 3 feet deep, 60 feet wide, 800 yards long; at Shell Reef, about 400 yards long; at Carancahua Reef, about 600 yards long, and Christian Point Reef, about 500 yards long. When the State of Texas dredged this channel in 1859 no timber or other material was used to prevent the filling up, the ebb and flow of the tide through the channel keeping it open without expense until partially filled in by shell and sand moved by the cyclone in 1875.

LETTER OF MR. BRANCH T. MASTERSON, ATTORNEY AT LAW.

GALVESTON, TEX., *December 6, 1890.*

DEAR SIR: In response to your inquiry as to the extent of the traffic to be benefited by opening the channel through the reefs in West Bay, I beg to report that in one season the traffic from Brazos River alone was as follows:

Sugar, 2,240 hogsheads	$224,000
Cotton, 3,600 bales	216,000
Molasses, 2,500 barrels	50,000
Hides, 8,000	30,000
Lumber, 445,000 feet	9,000
Merchandise, 20,300 barrels	203,000
Total	732,000

This only includes the freight of light-draft steamers, and would easily be doubled but for the fact that in low tides in winter, when the bulk of the crop is marketed, the steamers frequently take a week waiting for tides to cross the reef, and all freight that requires prompt and certain delivery could not come by the bay route. The commerce would not only be increased, but a reliable water route would result in greater competition and cheaper freight. One steamboat from the Brazos River running constantly has resulted in a reduction of 50 per cent in freight charges. In giving data I have omitted boats from Oyster Creek, Bastrop, and Chocolate bayous, as I have not the information as to them.

Very respectfully,

BRANCH T. MASTERSON.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

SURVEY OF WEST GALVESTON BAY, TEXAS, FROM CHRISTMAS (CHRISTIANS) POINT, WITH A VIEW OF REOPENING THE CHANNEL THROUGH WEST BAY.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 27, 1891.

GENERAL: I have the honor to submit herewith my report of a survey of "West Galveston Bay, from Christians Point, with a view of reopening the channel through West Bay," made in compliance with the requirements of sections 17 and 18 of the river and harbor act of Congress of September 19, 1890.

In my report of the preliminary examination of the bay, dated Decem-

ber 12, 1890, I wrote, referring to certain statements forwarded with that report, as follows:

It would appear from the report and statistics that the channels through West Bay to Christians (Christmas) Point are worthy of improvement by the General Government, provided the cost of such be not disproportionate to the extent of the traffic as stated.

A full survey from which to determine the cost of improvement was made in March and April last, excepting that the shore lines of Deer Island were run during the past month.

The survey, covering 39 square miles, 24 of which were sounded, was made under my direction by Mr. Gerald Bagnall, assistant engineer, a copy of whose report upon the same is herewith. The sum of $2,000 was allotted me for the purpose of making the survey.

It was necessary to sound large portions of the bay closely, as there had been no survey of the locality since 1880, and it was important to ascertain what changes, if any, had occurred in channels since that year. It was claimed by some interested in the navigation of the bay that channels excavated through the shoals by the State of Texas in 1859 had been more or less filled up by the cyclone of 1875. It appeared, therefore, as not unlikely that the cyclone of 1886 might have caused further filling of the channels.

The act authorizes an examination or survey, or both, "from Christian's Point." From direct information gained it was evident that the point of land lying between Bastrop and Oyster bays and about 3 miles west of San Luis Pass was the point meant in the act. On the U. S. Coast Survey chart this point is marked as Christmas Point, by which name it is most generally known. The channel passing along the point is claimed to be the most difficult of navigation of any of the channels.

The survey commenced at a point between the railroad bridges which cross from Galveston Island to the mainland of Texas and Deer Islands, and extended to the west end of Oyster Bay, the whole being regarded as West Bay.

The ruling depth at mean low tide from the railroad bridges to San Luis Pass is 3½ feet, excepting at Karonkaway Reef, where, in a few places, it is 3.2 feet. For considerable distance there is a depth of 5 feet.

In San Luis Pass, which connects West Bay with the Gulf of Mexico, the depth is, according to U. S. Coast Survey chart, 7 to 8 feet. The ruling depth in Oyster Bay up to the entrance to the Galveston and Brazos Canal, which connects that bay with Brazos River, is 3 feet, excepting for a short distance, over which it is 2.8 feet. The depth in the canal has been increased by dredging during the past season, as I am informed, to 7 feet.

The average rise of the tide in West Bay is about 1 foot. During the prevalence of "northers" the depth in the bay is considerably less than that at mean low tide, and vessels are at such times subject to delay.

The canal is owned and operated by a private corporation, which has the right to exact tolls of vessels making use of it. Improvement of the mouth of the Brazos River is also carried on by a private corporation, which is empowered to collect tolls under certain regulations. Vessels entering Brazos River from the Gulf of Mexico, and conversely, pass through one or the other of these improvements.

The difficulty in navigating West Bay is due to insufficient depth, principally during "northers," and to narrow and tortuous channels at a number of points, as can be seen by inspection of the map* herewith.

* Not printed.

Those interested in improvement of West Bay are desirous of securing a depth of 5 feet in the channels at low tide. The cost of excavation to secure continuous channels of least width of 100 feet and of depth of 4 feet, also of 5 feet, is given below.

Following the line of the present channel, which is marked on the map *c, g, p, q, v*, there will be required, in order to obtain a depth of 4 feet, the excavation and removal of 216,029 cubic yards of material, at an estimated cost of	$95,052.76
For a 5-foot depth the quantity to be excavated and removed would be 501,112 cubic yards, at an estimated cost of	220,489.28
Following the most direct route through the bay, marked on the map *c, g, i, q, v*, the quantity of excavation required for a 4-foot depth would be 213,012 cubic yards; estimated cost	93,725.28
For a 5-foot depth, 480,155 cubic yards would have to be excavated, at an estimated cost of	211,268.20

The cost per cubic yard is placed at 40 cents on account of the distances through which the excavated material would have to be conveyed. To the cost of dredging has been added 10 per cent to cover contingencies of engineering and inspection.

The expense of dredging channels of the depths just given, and to a width of 200 feet, would be nearly double that of 100-foot channels.

The cost of any one of the foregoing is regarded as beyond proportion to the amount of present or immediately prospective commerce that would be benefited by such improvement.

There are two steamers at present navigating West Bay, carrying freight and passengers between Brazos River and Galveston. They are the *Whitewater*, with carrying capacity of 550 bales of cotton, and the *Emily P.*, of 150 bales capacity. A new steamer, the *Hiawatha*, of 1,200 bales capacity, has been purchased and is now on her way from New Orleans to be added to the line of steamers navigating the bay.

It is stated in the letter of Mr. Branch Masterson, vice-president of the line (copy of letter herewith), that the freight transported during the past ten months by one of the steamers aggregated about 4,000 tons, of an approximate value of $800,000. He could not state the total amount of freight in tons carried by the steamers or by the small sailing craft that also bring cotton and other produce from the Brazos to Galveston. It is his opinion that an improvement to admit of steamers crossing the reefs without waiting for high tide would result in more than doubling the commerce.

Considerable improvement of the navigation would result from straightening the channels and removing the points bordering them, and also from effecting a trifling amount of deepening by dredging so as to afford a least width of 200 feet and depth of 3½ feet in the bay between the railroad bridges and San Luis Pass, and least width of 100 feet and depth of 3 feet along Christmas (Christians) Point, following the line of existing channel *c, g, p, q, v*, the reason for the difference in width and depth for the two being that the former portion is navigated by more and larger sailing vessels than is the latter, which is principally used by the steamboats of the company, which are of light draft.

Such an improvement would call for excavation as follows:

Between the railroad bridges and San Luis Pass ....cubic yards..	48,740
In Christmas (Christians) Point Channel ....do....	11,040
	59,780
At 40 cents per yard	$23,912.00
Add 15 per cent for contingencies of engineering and inspection	3,586.80
Total for dredging	27,498.80

The material to be dredged is composed mostly of a mixture of mud, sand, and shells.

If an improvement is ordered, the channel should be marked by suitable beacons, the estimated cost of which is $1,500 in addition to that just estimated for dredging. These sums, aggregating $28,998.80, can, in my opinion, be profitably expended in the interest of the public in reducing the difficulties in the way of navigation through West Bay, and should Congress order the improvement the amount estimated ($28,998.80) can be profitably expended in one year.

A small amount of redredging might in time become necessary, though it is believed that dredging in West Bay will be reasonably permanent.

STATISTICAL.

The locality under survey is in the collection district of Galveston, Tex., at which port the revenue collected for the fiscal year ended June 30, 1891, was $174,489.92.

The nearest light-houses are at Half-Moon Reef and Redfish Bar, in Galveston Bay, and at Bolivar and Fort Point, at entrance to Galveston Bay.

There is a United States life-saving station at San Luis Pass, and also one at Fort Point.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 9, 1891.

Respectfully forwarded to the Chief of Engineers.

The views of the district engineer are concurred in.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 16, 1891.

MAJOR: I have the honor to submit the following report on the survey of West Bay and Christmas Point, made in accordance with your instructions, together with estimates for the construction of a channel.

The survey was commenced on March 2, 1891, and completed on April 18, 1891. The area surveyed embraces about 39 square miles, of which 24 square miles was sounded over. A system of triangulation connected with the triangulation stations in Galveston Bay was carried down to Karonkaway Point, and repeated angles read at each station. A base line 15,055.1 feet long was measured from △ 1 to △ 3, and the work checked at the lower end by a measured line from D to E. At Christmas Point a base line 2,820.8 feet long was measured from P to P′, and an independent system of triangulation laid out embracing 6 stations. About 55 miles of shore line was run in West Bay, and about 7 miles in Oyster Bay. The stations on shore had

tripods erected over them, while those in the water consisted of a simple pole with a ball on top. In West Bay 13 tripods were erected, including one at Virginia Point not shown on map, and 4 single poles. In Oyster Bay 4 tripods and 2 single poles were used. The location of the stations is marked on the ground by galvanized iron rods 7 feet long and boiler tubes, both being placed at the principal stations, while tubes only were put at the others.

TIDE GAUGES.

Five tide gauges were established in West Bay and one in Oyster Bay. In West Bay T. G. No. 1 was established on the railroad trestle, No. 2 north of Deer Island, No. 3 about 2 miles south of Deer Island, No. 4, 2 miles above Karonkaway, and No. 5 off Karonkaway Point.

A line of levels was run from the B. M. on the Hendley building to the railroad trestle across West Bay and connected with T. G. No. 1, at which hourly readings were taken night and day for two months. The other gauges were connected with this by comparisons of high and low water readings, the observations having been taken when practicable during the progress of the survey. As a check No. 1 was connected with No. 3 by a line of levels run down the island shore to a temporary gauge at the nearest point of shore, which was connected with the latter by water level comparisons. In like manner the result of comparisons between readings on Nos. 4 and 5 was checked. At Christmas Point it was not practicable with the means and time at our disposal to get a tide record covering a sufficiently long period by which to establish a correct plane of mean low tide. It was therefore thought best to use a plane deduced from the survey of 1880. The plane thus found and used was secured by a bench mark.

BENCH MARKS.

Bench marks were established on the nearest point of shore to each of these gauges and are as follows:

B. M. No. 2 is an iron bolt in center of an old 12 by 12 pile west of the first bent on the railroad bridge and on the southwest side of bridge 18 inches from present south pile of said bent.

B. M. *b* is a square-headed iron bolt driven to the surface of ground close to the iron tube at △ *b*. Its elevation above mean low tide is 4.210 feet.

B. M. No. 10 is a square-headed iron bolt driven to the surface of the ground near a bush on shell reef opposite station 3 and in line with station 3 and Galveston Water Tower. Its elevation above mean low tide is 3.645 feet.

B. M. No. 1 is a round iron bolt driven within 2 inches of the ground at Karonkaway Point and located by the following sextant angles:

7 and C......43° 52′ 40″
C and 5......30° 32′ 40″
5 and 6......72° 58′ 40″

Its elevation above mean low tide is 3.965 feet.

B. M. No. 3 is located 1 foot north of B. M. No. 1. It is a square-headed bolt driven close to the surface of the ground. Its elevation above mean low tide is 3.801 feet.

B. M. No. 4 is an iron bolt driven within 2 inches of the surface of the ground and the main land opposite station X. It is located by the following angles:

7 and C......20° 35′ 00″
C and 5......34° 10′ 00″
A and B......79° 18′ 00″

Its elevation above mean low tide is 3.597 feet.

The B. M. at Christmas Point is a square-headed iron bolt driven to the surface of the ground about 1 foot from the boiler tube at P. Its elevation is 5.545. The elevation of top of the boiler tube is 7.065.

The survey embraced those portions of the route between the railroad bridge at the northern extremity of West Bay and the entrance to the Brazos River Canal, where a depth of 5 feet could not be found. The width surveyed at the different points depended on the following conditions: Where the best route was well defined, as was the case near Deer Island, the area surveyed was limited to shoal water on each side of present channel; at points, however, where doubt existed as to the most economical route, as was the case about Karonkaway, the survey was then made to embrace nearly the full width of the bay.

ESTIMATES.

Estimates for a 4-foot and for a 5-foot channel 200 feet wide have been made over two lines, one following the most direct practicable route, the other following the present steamboat channel as shown by dotted line on chart. Another estimate has

been made for improving the present route to the extent of cutting off points and widening the passage through the reefs, giving a minimum depth in West Bay of 3½ feet at mean low tide, and in Oyster Bay a minimum depth of 3 feet at mean low tide. This latter estimate does not contemplate increasing the normal depths of the bays.

In making up the quantities an extra depth of 0.5 foot was added to cover unavoidable excess of depth of cutting. As this is a small margin the price per cubic yard has been slightly increased over what it would have been with a larger margin of depth.

The estimated cost has been placed high on account of the difficulty of disposing of the material in a shoal-water bay, combined with the light cutting required. The total length to be dredged, following the most direct route, is as follows:

	4-foot channel.	5-foot channel.
	Feet.	*Feet.*
In West Bay	34, 555	53, 855
In Oyster Bay	17, 500	17, 500
	52, 055	71, 355

The amount of material to be removed would be for a—

	4-foot channel.	5-foot channel.
In West Bay .... cub. yds..	282, 375	697, 377
In Oyster Bay .... do....	163, 474	282, 759
	445, 849	980, 136
At 40 cents per cubic yard	$178, 339. 60	$392, 054. 40
Add 10 per cent for contingencies	17, 833. 96	39, 205. 44
Totals	(1) 196, 173. 56	(2) 431, 259. 84

Following the present steamboat channel the amount to be dredged and cost would be as follows:

	4-foot channel.	5-foot channel.
In West Bay .... cub. yds..	288, 408	739, 290
In Oyster Bay .... do....	163, 474	282, 759
	451, 882	1, 022, 049
At 40 cents per cubic yard	$180, 752. 80	$408, 819. 60
Add 10 per cent for contingencies	18, 075. 28	40, 881. 96
Totals	(3) 198, 828. 08	(4) 449, 701. 56

Estimated cost of widening through the reefs and cutting off points, etc.:

In West Bay .... cub. yds..	48, 740
Christmas Point .... do....	27, 600
	76, 340
At 40 cents per cubic yard	$30, 536. 00
Add 20 per cent for contingencies	6, 107. 20
Total	36, 643. 20

The amount of work estimated for in the last case would provide sufficient depth for most if not all the commerce at present using these bays, except during severe northers.

A reduction of width of channel in the above estimates will give more than a pro-

portional reduction in the quantities. This is especially so in the case of estimate No. 5, where a reduction of width to 100 feet would reduce the amount to be excavated in the proportion of 2 to 5. In the case of estimates Nos. 1, 2, 3, and 4 this would be very much smaller.

The cost of dredging per cubic yard could be reduced by depositing the material alongside the cut, but while this might safely be done in Oyster Bay there would be danger of the material washing back in West Bay on account of its greater extent and depth.

The material in West Bay and Oyster Bay is principally composed of a mixture of mud, sand, and shell, with occasional reefs of oyster shell. It is probable that any channel dredged through them will maintain its depth fairly well, as the currents are in the direction of the proposed cut, but for greater permanency it would be necessary to revet each side of the dredged channel, at least in some places.

A further provision should be made for the erection of beacons at an approximate cost of $1,500.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

LETTER OF MR. BRANCH T. MASTERSON.

GALVESTON, TEX., *November 27, 1891.*

DEAR SIR: In response to your inquiry as to the present condition of the traffic passing through West Bay, I regret that from the nature of the trade it is impossible to state the exact tonnage, because a number of schooners are passing at irregular times when the high tides admit of their crossing the reefs, loaded with freight, going and coming, and when the steamboats running regularly are delayed by low tides in crossing the reefs, the freights are diverted and find their way to market by hauling to nearest points on railroads and paying the additional cost. I have taken from the books of one steamer, making one trip per week, the amount of freight transported by her in the past ten months, and find it aggregates about 4,000 tons, of an approximate value of $800,000. The owners of the boat found the traffic increasing so that within the past ninety days they have purchased another steamer and have been running four trips each way per week. Both steamers have had tendered them so much more freight than they can carry that a third steamer has been purchased within the past ten days, having a carrying capacity of 300 tons, and will be placed in the trade at once. The trade has doubled within the past ninety days, and if relieved of the delays caused by waiting for tides to cross the reefs in West Bay, I feel certain of a further increase of over 100 per cent by the coming season.

Very respectfully,

BRANCH T. MASTERSON.

Maj. CHAS. J. ALLEN,
U. S. Engineer.

APPENDIX V.

IMPROVEMENT OF CERTAIN RIVERS AND WATERWAYS IN LOUISIANA, TEXAS, ARKANSAS, MISSISSIPPI, AND TENNESSEE, TRIBUTARY TO MISSISSIPPI RIVER; WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPTAIN J. H. WILLARD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Red River above Fulton, Arkansas.
3. Ouachita and Black rivers, Arkansas and Louisiana.
4. Bayou D'Arbonne, Louisiana.
5. Bayou Bartholomew, Louisiana and Arkansas.
6. Bayou Boeuf (Boeuf River), Louisiana.
7. Tensas River and Bayou Maçon, Louisiana.
8. Bayous Rondeway and Vidal, Louisiana.
9. Big Black River, Mississippi.
10. Yazoo River, Mississippi.
11. Tchula Lake, Mississippi.
12. Tallahatchee River, Mississippi.
13. Steele and Washington bayous, Mississippi.
14. Big Sunflower River, Mississippi.
15. Big Hatchee River, Tennessee.
16. Forked Deer River, Tennessee.
17. Water gauges on Mississippi River and its principal tributaries.
18. Survey of Cypress Bayou and the lakes between Jefferson, Texas, and Shreveport, Louisiana.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 1, 1892.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1892.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

V 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

The Red River of the South has its source in the *Llano Estacado*, northern Texas, and flows in a general easterly direction, forming the boundary between Indian Territory and Texas. At Fulton, Ark., its course changes to a general southeasterly direction, and after crossing the State of Louisiana it enters the Mississippi River at Red River Landing. The entire length of the river is about 1,200 miles; the part included in the project under the head of improving Red River, Louisiana and Arkansas, extends from Fulton, Ark., to the mouth of Atchafalaya River, Louisiana, a distance of 507 miles.

The importance of keeping this great waterway open to navigation was recognized by the United States as early as 1828, and appropriations aggregating $535,765.50 were made at intervals between 1828 and 1852. Between 1841 and 1852 no appropriation was made for carrying on the work, and a longer period elapsed between 1852 and 1872, during which the results of former work were lost. Between 1855 and 1860 the heavy rates of freight and insurance and the effects of the backwater caused by the great raft became so burdensome to the planting interest above that obstruction, that a charter was obtained from the State of Louisiana for the removal of the main raft by a stock company. The assent of Congress having been given to the project by joint resolution of February 21, 1861, and the company authorized to levy tolls for a period of thirty years (Stat. L., vol. 12, page 250), the stock was taken by the planters interested, and the company was ready to commence work in the spring of 1861, but the war of the rebellion broke out and nothing was done.

An examination and survey of Red River from the mouth to a point above the raft in Louisiana were ordered by river and harbor act of March 3, 1871, the reports upon which are contained in Reports Chief of Engineers, 1872, pages 568–573; and 1873, pages 635–676. The present improvement was commenced in 1872. The original project contemplated removing the raft above Shreveport, La., and closing Tones Bayou Outlet, on the right bank, 19 miles below Shreveport, the gradual enlargement of which diverted a large quantity of water from and seriously affected navigation of the main river below. Subsequently this project was enlarged to include the removal of jams, snags, wrecks, leaning timber, etc.; opening and enlarging the channel through the falls at Alexandria, La.; deepening the channel at shoal places; and closing the Sale and Murphy Outlet, on the right bank, 66 miles above Shreveport; in order to improve and keep navigation open from Fulton, Ark., to the mouth of the Atchafalaya; also to protect the bank at Alexandria from erosion by the current of the river; and to make a thorough and comprehensive survey from Fulton to the mouth, with a view to the permanent improvement of the river.

The appropriations for the early work, from 1828 to 1852, were as follows:

Date of act.	General object of appropriation.	Amount.
May 23, 1828	Improving navigation of Red River through or around the raft in Louisiana and Arkansas	$25,000.00
Mar. 2, 1831	Arrearage due Maj. Burch for survey of raft of Red River, Louisiana	187.50
July 3, 1832	Improving navigation of Red River, Louisiana and Arkansas, being balance of appropriation of 1828 carried to surplus fund, and the further sum of $20,000	22,628.00
June 28, 1834	Improving navigation of Red River	50,000.00
Mar. 3, 1835	Completing removal of obstructions to navigation of Red River	50,000.00
July 2, 1836	Continuing the removal of obstructions in Red River	40,800.00
	Constructing a boat to prevent a new accumulation of obstructions in Red River within the old limits of the great raft, $15,000, and to work and support same, $15,000	30,000.00
Mar. 3, 1837	Continuing the removal of obstructions in Red River	65,000.00
Apr. 20, 1838	The complete removal of the great raft in Red River	70,000.00
Mar. 3, 1841	Removing the raft of Red River	75,000.00
Mar. 2, 1847	Deficiency of appropriation by act of April 20, 1838, being amount advanced by Daniel T. Witlee and others through the branch of the Real Estate Bank of Washington, Ark., to Henry M. Shreve, Government agent, for removal of great raft, and expended by him for that purpose	7,150.00
Aug. 30, 1852	Removing the raft of Red River	100,000.00
	Aggregate of appropriations, 1828–'52	535,765.50
	Amount expended	532,219.90
	Amount carried to surplus fund	3,545.60

The appropriations for the improvement commenced in 1872 have been as follows:

Date of act.	General object of appropriation.	Amount.
June 10, 1872	Improvement of Tones Bayou, Louisiana	$20,000.00
	Removing the raft in Red River, Louisiana	150,000.00
Mar. 3, 1873	......do	80,000.00
June 23, 1874	......do	50,000.00
Mar. 3, 1875	......do	20,000.00
Aug. 14, 1876	Removing the raft in Red River and closing Tones Bayou	35,000.00
Apr. 10, 1869	Allotment made August 27, 1877, for closing Tones Bayou	4,500.00
Feb. 7, 1878	Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for purpose of preserving vessels of United States employed in that work	6,000.00
June 18, 1878	Removing raft in Red River and closing Tones Bayou	24,000.00
	Removing snags and other obstructions from Red River	25,000.00
Mar. 3, 1879	Removing raft in Red River and closing Tones Bayou	15,000.00
	Removing obstructions from Red River	22,500.00
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000.00
June 14, 1880	Removing raft in Red River and closing Tones Bayou	25,000.00
	Removing obstructions from Red River, Louisiana, including construction of snag boat	60,000.00
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000.00
Mar. 3, 1881	Removing raft in Red River and closing Tones Bayou	10,000.00
	Removing obstructions from Red River, Louisiana	10,000.00
Aug. 2, 1882	Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river	75,000.00
July 5, 1884	Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river	75,000.00
Aug. 5, 1886	Continuing improvement from Fulton, Ark., to the Atchafalaya River, Louisiana, including completing the work at Alexandria; $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya, and in completing survey of Bayou Pierre, Louisiana	75,000.00
Aug. 11, 1888	Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria; $5,000, or so much thereof as necessary, to be used upon Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.; and $5,000, or so much thereof as necessary, upon Bayou Dorcheat	65,000.00
	Completion of survey from Fulton, Ark., to the Atchafalaya River	35,000.00
Sept. 19, 1890	Continuing improvement from Fulton, Ark., to the Atchafalaya River; $15,000 to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point; and $5,000 in closing the Sale and Murphy Outlet	100,000.00
	Completion of survey from Fulton., Ark., to the Atchafalaya River	28,000.00
	Aggregate of appropriations, 1872 to 1892	1,030,000.00

The amount expended to June 30, 1891, under the project of 1872 was $926,024.52 (including outstanding liabilities of $429.46), resulting in great benefit to navigation. In 1872 the upper river was closed by the great raft, extending from Carolina Bluffs, 33 miles above Shreveport, La., upstream 32 miles, to within 4 miles of the Louisiana and Arkansas State line, and added to by each flood. A channel was opened through this obstruction in 1873, and operations since, aided by the action of the current, have secured greater width and depth throughout the entire reach, with a channel-way constantly widening and scouring, until at the present time but little water is diverted from the river proper except at flood stages. Moderate estimates, made in 1872, showed that the removal of this obstruction alone resulted in a saving of $150,000 annually to the planting interest above the raft, besides relieving, to a great extent, not less than 25,000 acres of productive lands from overflow. (Report Chief of Engineers, 1873, page 665.) The work of removing obstructions from the channel, clearing the banks, and the prompt breaking of all jams and keeping the drift in motion during high stages of water have prevented renewal of the raft.

Several attempts were made to close Tones Bayou, but no work has been done at that outlet since 1882, when the dam under construction was destroyed. The bayou is filling up gradually with drift, and this in connection with the work in the old raft region is causing the "Little River" (below the mouth of Tones Bayou) to widen and scour, the effect having been particularly noticeable within the last three years. The rock excavation and dam at the Falls of Alexandria were completed in 1885, increasing the period of navigation about 2 months, and as a general thing permitting boats to pass the falls the year round, though passage is somewhat difficult at extreme low stages on account of the deflection at the middle of the cut. The dam and training wall for protecting the bank at Alexandria, built in 1884-'85, accomplished the purpose for which intended, and it is plain that the banks no longer cave within their influence. The removal of snags, logs, and wrecks from the channel and clearing the banks for the general improvement of the river were not begun until 1878, all former appropriations having been for the removal of the raft and closing Tones Bayou, but since 1885 operations have consisted chiefly of that class of work. In March, 1887, circular letters were sent to persons interested in navigation of Red River, asking information regarding wrecks, their location, amount of obstruction, etc. Five lists were received, giving names of boats, causes of loss, and specifying those that were serious obstructions. Upon comparison it was found that in fifty years 197 steamboats had been lost in Red River; one list gave 86 snagged, 21 burned, 11 destroyed during war, 4 exploded, and 3 destroyed by collisions. Attention is invited to the foregoing as evidence of the fact that navigation is becoming better and safer every year, for during the last two years steamboats made regular trips at lower stages than ever known before, without detention or serious accident.

The removal of snags and other obstructions should be continued, however, for many years. In the old raft region, both above and below Shreveport, sunken logs and stumps are scouring loose continually and are a constant source of danger to low-water navigation. Others, thoroughly water logged, form bars, impassable at low stages. The banks of the upper river, for hundreds of miles, are covered with a heavy growth of timber, which is caving and sliding into the river continually, and during high stages the amount of drift is enormous. In the raft region, above Shreveport, jams form in a few hours, often acres in extent, and require prompt removal before the water falls. Caving banks leave dangerous shore snags projecting far out into the river which should be cut after every rise and fall.

As stated heretofore, whatever plan may be adopted for the permanent improvement of Red River, or even if the work of giving an assured reasonable navigation to Shreveport and beyond be delayed for a time, there are certain general principles to be followed, if only to save till that time comes what has been gained, or to prevent the river closing. These principles are stated in natural sequence, as follows:

1. The systematic clearing of the banks for some distance back, far beyond the limits of this district. It is cheaper to remove the source of drift than to dispose of the drift itself; and the benefit to navigation is immediate.

2. An efficient snag boat service for general work, patroling the river, preventing jams, removing snags and logs from the channel and banks, and dredging tow-heads and obstinate shoals. Here, again, the bene-

fit is immediate. A permanent appropriation of not less than $25,000 a year is needed for this purpose.

3. Extending the scope of the survey to embrace the whole valley. This is necessary to the proper study of this river and tributaries, and to furnish all the information required to decide upon a system of improvement and to locate its elements.

4. Construction of a substantial system of levees to restrain the greatest floods, either alone or in conjunction with the riparian States.

5. Closing gradually every outlet through which the main stream is depleted at various stages above low water.

6. Fixing caving banks to confine the main stream to the channel selected for it. Ordinarily fixing caving banks should precede levee building and closing outlets, but as the banks are reasonably stable for a considerable part of Red River, and as the object is to get improved navigation without unnecessary delay, revetment is placed after them.

7. To exercise a watchful care, from first to last, to prevent injury to the regimen of the river by cut-offs or outlets, and to keep the building of bridges within reasonable bounds.

During the fiscal year ending June 30, 1892, operations were continued as follows:

GENERAL IMPROVEMENT.

The United States snag boat *C. W. Howell*, M. B. Lydon, master, which had been employed for a short period during June and July in the Lower Ouachita and Black rivers, resumed work in Red River at Alexandria, La., July 19, 1891. Subsequent operations of that boat are given in detail, as follows:

July 19 to August 1 the boat worked upstream to Shreveport, removing all obstruction in sight and all that could be reached with drag chain. Dynamite was used occasionally for destroying large snags in the channel. The boat remained at Shreveport Sunday and Monday, August 2 and 3, cleaning boilers, receiving supplies, and undergoing minor repairs, and August 3 work above Shreveport was commenced, and continued between that place and Gilmer, La., 45 miles above, until August 9. A rise at that time set considerable drift running, and the boat was employed August 10 in clearing a jam at the Shreveport Bridge, and August 11 to 14 in patroling the river between Shreveport and the Arkansas State line. August 14 work below Shreveport was resumed and carried down stream to Barbin Landing, 60 miles above the mouth of Atchafalaya. September 1 to November 2 the boat continued removing obstructions from the channel of the lower river between Barbin Landing and Shreveport. The stages of the river were near extreme low water throughout this period, and effective work was done; the masters and pilots engaged in navigation at the time expressing their approbation by written testimonials to the master in charge of the *Howell*. Scarcity of fuel, excessive heat, and much sickness amongst the crew were the only disadvantages to the work. Large numbers of obstructions were removed at the following places, viz, Golconda Bend, near wreck of *Gladiola*, at wreck of *Glide No. 2*, near Cyrus Perot Landing, Boyce Bend, Shortway, Greening Bend, and near Matilda Taylor Landing, and the sweep chain was dragged over all crossings where there was less depth than 6 feet. At Shreveport a new canvas roof was put on and the broken balance rudder repaired,

and November 9 the boat left Shreveport and worked between that place and Knox Point, 40½ miles below, until November 16. In coming around the bend at Knox Point on the latter date the boat struck a hidden snag and knocked a hole in the iron bottom about 5¾ feet long by 6 inches wide. The leak was bulkheaded, and the boat resumed snagging operations next day, and worked back upstream, arriving at Shreveport the morning of November 26. The principal work done November 9 to 25 was in the "Little River," below the mouth of Tones Bayou to Knox Point, where all bad places were dragged over four times with the sweep chain; each time about as many logs were removed, and great numbers loosened and came to the surface as the bottom scoured.

November 26 to 28 a small sectional dock was built at Shreveport and sunk under the bottom of the *Howell*, and November 29 a half sheet of iron was riveted over the break. After completing the repairs the *Howell* remained at Shreveport until December 8, the crew having been employed in constructing a jetty above the bridge for the purpose of deflecting the channel so as to wash away the sand bar that had formed across both draw openings, preventing steamboats from passing the bridge at low stages. This jetty, an inexpensive structure built of old lumber and brush, ballasted with sacks of earth, refuse brick, etc., was completed December 7, and appeared to give temporary relief at least, as the master of the *Howell* took soundings while passing through the draw December 26 (gauge reading 8 feet) and found no bottom with 12½ foot poles. From December 8 to 26 the boat was employed between Shreveport and Campti, 124 miles below, after which and until February 10 it was employed above Shreveport. During the latter period, December 27 to February 10, the entire stretch of the upper river, from Shreveport to Fulton, was worked over. January 8 the *Howell* was overtaken near Carolina Bluff, 33 miles above Shreveport, by the snag boat *Wagner*, and the latter was directed to continue operations up to Head of Raft. The *Howell* being better adapted to heavy work, turned back to go over the narrow river again, as the water had fallen about 3 feet to a most favorable stage for operations in that reach. On the way down the boat removed loose stumps and cleared out a badly obstructed part of the river at the Dawn Stumps. At Pandora (the head of navigation at extreme low water) 7¼ miles above Shreveport, the river was jammed completely with drift. The jam was broken January 11 and the entire day was spent at that place removing wrack heaps from the bottom. Excessively cold weather, with snow and sleet, prevented any work January 12, as it was impossible to handle the rigging, and as the boat was out of fuel it ran down to Shreveport for coal. A car load of coal was delivered on board January 13, and the next day the weather moderated sufficiently to permit clearing the decks of ice and snow, and at noon the boat left for the upper river to resume operations. From Shreveport to Carolina Bluff the river was worked over for the third time, but above the latter place to Hervey Canal, 21¾ miles, nothing was done, as the *Wagner* had just passed over that stretch, putting it in good condition for navigation. January 21 the *Howell* overtook the *Wagner* at Hervey Canal and resumed operations, which were carried up to Fulton, Ark., February 5, and owing to the rapid fall of the upper river a great number of obstructions were exposed, and effective and heavy work was done. Some obstructions were reported in the channel at the St. Louis, Iron Mountain and Southern Railway Bridge at Fulton, but owing to the low stage of water the *Howell* was unable to get nearer than a quarter of a mile of that struc-

ture, and a party was sent by skiff to remove all snags, etc., badly in the way, by means of explosives.

After completion of this work, the boat started downstream, doing such work as was found necessary on the way. The plan heretofore pursued of depositing logs and snags in the deep bends and piling heavy trees on the caving banks has proved successful, and the master of the *Howell* reported that the banks were caving at but few places where this had been done. The boat reached Shreveport February 10, where the crew was discharged, and the boat and machinery put in order and laid up at the fleet in Cross Bayou, as it was not deemed advisable to attempt further continuous work, owing to the reduced balance for the general improvement of the river, and because the period at which high water might be expected had set in. The *Howell*, however, was kept in readiness to be sent out without delay to patrol the river when necessary and remove any formations of raft that might occur. A rise of the upper river the early part of April caused heavy drift to run, and Saturday, April 2, information was received by the master of the *Howell* that the river was jammed at Rush Point, 33½ miles above Shreveport. A small crew was shipped at once, and on Monday, April 4, the boat left Shreveport for Rush Point, clearing the river of side jams and other obstructions on the way up. Work at the jam at Rush Point was commenced April 7 and completed April 8, and the following day was spent in going over the reach and removing logs and stumps as they scoured loose from the bottom, after which, as there was little drift running, the boat returned to Shreveport. Later in the month of April the boat was employed in Little River below the Scopini Cut-off, and the work done is reported under that head. A heavy rise set in the early part of May, bringing down a large amount of drift, which jammed at the Shreveport Bridge. A minimum crew was shipped on the *Howell* May 5, and the jam was removed, after which the boat remained below the bridge until the morning of May 7, keeping the drift in motion and waiting for the heavier material to pass. By the 7th of May the drift almost stopped running, and the boat left at 7 a. m. that date for the upper river, removing obstructions on the way, and reached the Sale and Murphy Outlet at 8 a. m., May 10. An examination of the dam at that place was made, and it was found that the water was scouring the lower end. All hands were put to work piling brush upon the dam to protect it from scour and weighting it down with heavy green logs. Having completed this work and secured the dam from further damage, the boat left for Shreveport at 6 a. m., May 11, and arrived at that place at 5 p. m. the same day, where the crew was discharged. At 7 a. m., May 14, word was received that the steamer *Rosa Bland* was caught in a jam at Hervey Canal, and the *Howell* left Shreveport at 10:30 a. m., and arrived at the jam and commenced towing drift intc the current Sunday morning, May 15. About 5 p. m. that date one rudder coupling broke and the other was bent, and in attempting to remove the latter it dropped into the river. After searching nearly all night it was recovered and a new coupling made, and the work of towing drift was resumed at 6 a. m. the following morning and the steamer *Rosa Bland* released two hours later. The jam, caused by cross currents, was about 1 mile in length, and all the drift had to be towed 1½ miles. This work was not completed until the morning of May 17, after which the boat continued operations up to the Sale and Murphy Canal, and returned to the fleet at Shreveport at noon May 18.

The rise continued until it culminated in the most disastrous flood

that ever visited the Red River Valley, reaching a maximum height of 35.7 feet on the Shreveport gauge May 28, 1 foot above the high water of 1890, the highest previously recorded. On May 15 the levee broke near Garland, Ark., and subsequently breaks were of frequent occurrence all along the river, destroying the crops and lands, washing buildings away, and driving the people and their stock to the hills for safety. At the solicitation of the mayor of Shreveport, and under the authority of the Secretary of War, the snag boat *Howell*, under command of M. B. Lydon, and the *Wagner*, under command of P. R. Starr, were employed the latter part of May and early part of June in saving life, and did good service in the reaches above and below Shreveport at a minimum of cost, and the Shreveport papers and the people along the river were filled with praise and thanks for the prompt and efficient aid rendered the flood sufferers in the way of rescuing life and saving property in the overflowed districts.

On June 15 word was received from the Red River Line that a large amount of drift had jammed at Natchitoches Bayou, Lower Red River, near mouth of Black River, and that the river was impassable for steamboats. The *Howell* left Shreveport at 4 p. m. that date, arrived at the jam late June 17, and worked through the obstruction. An examination was made the following morning, and it was found that the only way to get rid of the drift was to pull it through the bayou to the lower outlet, about 12 miles above the mouth of Atchafalaya. A raftsman familiar with the bayou was hired, and the boat ran down to the lower mouth and came up through the bayou to the foot of the jam. Work was commenced June 19, but great trouble was experienced in keeping the drift in motion after it was started downstream, but the operations finally were completed and the drift all towed out June 22. After the jam was cleared the boat returned to Shreveport, reaching that place June 30, where it was laid up at the fleet and the crew discharged.

The following is a summary of the work done by the *Howell* for the general improvement of the river during the year:

Snags pulled	1,927
Stumps pulled	282
Shore snags cut	656
Logs removed from channel	3,035
Jams removed	9
Side jams removed	105
Leaning trees cut	332
Leaning trees topped	3
Hard-clay points removed with explosives	5

Wrecks removed, viz: part of steamer *Glide No 2*, sunk 1865, below Campti; and small barge at Mercer Landing.

Protected dam at Sale and Murphy Outlet by piling brush and heavy green trees on slopes to prevent scour.

The repairs of the United States snag boat *O. G. Wagner* were completed at Shreveport October 5, 1891, but as it was impracticable for the boat to reach the Upper Ouachita at the extreme low stages then prevailing, it was employed temporarily in Red River, under command of B. S. Lewis and G. W. Aills, both efficient Red River steamboat men. Details of the work done are given below.

The boat left Shreveport October 6 for Lower Red River, where it was employed until January 3. October 6–28, operations were confined to the stretch known as the "Little River," below Tones Bayou, to Knox Point. On the latter date the boat was sent to continue work where left off by the *Howell*, near Grand Bayou, 81 miles below Shreveport. October 29–November 18, operations extended from Grand Bayou

upstream to Bates Place, 38 miles below Shreveport, where the *Howell* was met, and November 19, the *Wagner* started downstream. Alexandria was reached November 26, supplies were taken aboard, and the boat continued operations down to Creole Bend, 15 miles below Alexandria and 228 miles below Shreveport. From December 1 to January 3 the *Wagner* worked from Creole Bend back to Shreveport. Until December 23 the river remained at a low stage, but on that date, while working in Golconda Bend, 130 miles below Shreveport, heavy rains set, in causing the river to rise 7 feet by December 26, and, as it was believed that the rise would continue, the boat started for Shreveport, removing leaning timber from caving banks on the way, and towing the United States dredge *Lone Star* from Clydesdale, opposite Lotus Landing, to Shreveport, a distance of 22 miles. January 4 the dredge and snag boat *Breck* were towed to a safe mooring place in Cross Bayou, and after undergoing some minor repairs, cleaning boilers, and receiving supplies and fuel at Shreveport, the *Wagner* left January 6, to assist the *Howell* in the upper river, where it was employed until January 21. Operations commenced January 8 at Carolina Bluff, and were continued up to Hervey Canal, where work was suspended January 21. The boat returned to Shreveport the afternoon of January 22, and the following day it was put in order, laid up at the fleet, and the crew discharged.

The following is a summary of the work done by the *Wagner* October, 6, 1891, to January 21, 1892, viz:

Snags pulled	799
Stumps pulled	77
Shore snags cut	461
Logs removed from channel	823
Side jams removed	31
Leaning trees cut	525
Piles removed at Alexandria Landing	31

Wrecks removed: Part of machinery of steamer *Huntsville* (sunk 1873) at White Hall.

With the exception of the work of saving life during the flood in May and June, operations with the *Wagner* were not resumed to the end of the fiscal year.

The United States hand-propelled snag boat *Harry Breck*, W. W. Moore, overseer, in charge, continued the work of clearing the banks, removing shore snags, etc., from July 1 to December 31, 1891, as follows:

From July 1 to October 8, work was carried from Posten Bayou down-stream to Shreveport, a distance of 53 miles; caving banks were cleared for a distance of 30 feet back from the river, the trees and brush on the points were cut, and all leaning timber was chopped into short lengths to prevent future obstructions. The water was at a low stage during the greater part of the time, and all stumps and shore snags in sight were removed. Below Fish Place to Shreveport, 18 miles, the work was pushed as rapidly as possible, in order to take advantage of the extreme low stage of water, and only the obstructions ordinarily under water were removed, leaving the upper part of the banks to be cleared afterwards. October 9–10, the boat dropped from Shreveport down to the mouth of Tones Bayou, at Scopini Cut-off, and was employed in the "Little River," below Knox Point, until November 4. As the top banks in this stretch were cleared in 1890, rapid progress was made. After completing work in the "Little River" reach operations were continued down to the mouth of Loggy Bayou, 65 miles below Shreveport, which was reached December 2. December 3–17, the boat was cordeled from

the mouth of Loggy Bayou up to the Dawn Stumps, 9 miles above Shreveport, where in a stretch of a half mile 109 stumps were removed from the channel. Operations were continued upstream to Buck Hall, 15 miles above Shreveport, where work was suspended December 29. The boat was dropped down to Shreveport, laid up, and the crew discharged.

The following is a summary of the work done by the *Breck* in the six months ending December 31, 1891:

Snags pulled	5
Stumps removed	3,803
Shore snags removed	10,177
Leaning trees cut	7,630
Leaning trees topped	22
Trees girdled	359
Square yards brush and willows cut	107,325
Points removed with explosives	5
Tow-heads removed with explosives	1

Wrecks removed: Cylinder timbers of steamer *J. G. Fletcher* (sunk 1886) at Shady Grove, 12 miles above Shreveport.

November 30–December 9, I made an inspection of the river at the following localities, viz: Garland, Ark., Shreveport, La., at and near Alexandria, and the "Little River," below Shreveport to Waterloo Cutoff, 25 miles. On my return to Shreveport, December 9, I directed that the United States dredge *Lone Star* be sent to the river below, to assist in removing obstructions, and to take advantage of the low stage and cut off false points, etc.

The dredge, which had been laid up at Shreveport, received supplies and shipped a crew December 10, and in charge of Engineer G. W. Phillips started downstream to commence operations. The boat reached the wreck of the steamer *Richmond* (sunk 1868) at Devil Elbow, 11 miles below Shreveport, December 13. Work at that locality was begun the following day; 75 feet of the wreck were removed from the edge of the channel, and a cut 310 feet long was made through the bar below, ranging from 15 to 30 feet in width and 4 to 8 feet in depth; after which a cut was made on the opposite side of the river 230 feet long by 30 feet wide and 4 feet deep. This work was completed the morning of December 22, and the dredge dropped down to a point just above Long Branch, 21 miles below Shreveport, where a cut 350 feet long, 25 feet wide, and 6 feet deep was completed December 28. The next day a cut was commenced at a point opposite Lotus Landing, 22 miles below Shreveport, which was continued for a distance of 430 feet, ranging from 15 to 22 feet in width and 6 to 10 feet in depth. Owing to a rise of the river, the crew was discharged January 2, 1892, and the dredge was towed back to Shreveport the next day by the snag boat *Wagner*.

The following is a summary of the work done by the dredge:

Cubic yards of material excavated (approximate)	7,981
Snags pulled	1
Stumps pulled	13
Shore snags cut	3
Logs removed from channel	77
Log pile removed	1

Wrecks removed, viz: About 75 feet of steamer *Richmond* (sunk 1868) at edge of channel at Devil Elbow.

After suspension of work the snag boats *Wagner* and *Breck* and the dredge *Lone Star* were laid up in Cross Bayou, at Shreveport, La., in charge of G. W. Phillips, an experienced machinist and steamboat engineer, who has been employed on the snag boats in Red River for years, and who, with assistance of the watchmen, overhauled the boats and

machinery, and kept the plant in serviceable condition by timely repairs, painting, cleaning, pumping, etc. When not in service the snag boat *Howell* was laid up at the fleet in Cross Bayou, and the entire plant was placed under the supervision of the master, M. B. Lydon.

The removal of obstructions during the past year has been of great benefit to navigation, snag boats having worked over the entire river from Fulton to the Atchafalaya. Nearly all of this stretch was gone over twice. The narrow portions below Rush Point to Shreveport and below Tones Bayou to Knox Point were worked over three and four times; and during the prolonged season of low water last summer and fall the entire plant available was employed in removing obstructions from the channel and banks. This work resulted in immediate benefit, and the smaller steamboats made regular trips below Shreveport without hindrance during the period of extreme low water (the lowest of record) in November and December.

ALEXANDRIA.

The appropriation for improving Red River by act of September 19, 1890, provided that "$15,000 shall be used in the work at Alexandria." It was intended to apply this allotment to the enlargement of the channel through the upper falls by dredging, and to protecting the bank at Alexandria from abrasion by the current of the river. Revetment with mattress work, or stone alone, as used with success on the Mississippi, is to be preferred to any other kind of shore protection, but the property owners at Alexandria still are unwilling to give any part of the bank outside the town levee to be graded away, which would have to be done if revetment were adopted, to give an easy slope and prevent its sliding into the river, and their estimates of the compensation to be paid them for land damages exceed the entire amount of the allotment. On this account it has been advisable to put off the work as long as possible, because it has been a delicate matter to decide upon a bank protection other than revetment that shall form part of an intelligent plan for the permanent improvement of the stream. The property owners state that they will be satisfied with a repetition a little lower down of the crib dike built by the United States in 1884–'85, but since examination of the old dam, and investigation of the results obtained, I can not recommend a continuance of that form of work. The crib dike and training wall above not only are not required for improving navigation of Red River, but are a positive injury to it, scouring the bottom into a deep hole near by and causing shoals below, and not affording any marked protection to the bank above midstage. Being wet and dry at intervals, such work can not last many years, and its repair would be at least 50 per cent of first cost. Piling can not be used on account of the rock underlying the bottom at Alexandria. The division engineer advised revetment, either bank height or half-bank height, letting the upper bank fall in on the slope. Either form would require grading, and may be put in with or without mattress work. There is no stone within reasonable distance of Alexandria, except in the bottom of the river, and it would have to be brought by rail and delivered on the bank or in barges, making it very expensive, probably from $2.50 to $3 the cubic yard.

In view of the foregoing, and in order to be able to begin the work ordered by Congress, when the water again reaches a favorable stage,

the following project was submitted through the division engineer March 1, 1892, viz:

I have the honor to submit a project for expending the allotment of $15,000 for "work at Alexandria," made by the act of September 19, 1890, with three blue prints. Print A is compiled from surveys between 1886 and 1891, and shows the condition of the river from the Upper Falls to Alexandria. Print B is taken from the surveys of 1890 and 1891, with soundings changed to elevations in meters above Cairo datum. Blue print C gives sections during four surveys between 1874 and 1891. I am unable to lay down the shore lines or water surfaces given on the maps of 1874 and 1878 for want of common points. The notes of these earlier surveys were not only kept recklessly, but show erasures and alterations without explanations, and the Alexandria front was evidently sketched in; but from the best information I could obtain at Alexandria, I believe that the caving between Bayou Rapides and Beauregard street has been far less than stated.

Works of various kinds have been proposed at and above Alexandria, and some have been carried out somewhat as proposed, with indifferent success. Most of the reports upon the surveys, projects, and works are given in the reports of the Chief of Engineers, as follows: 1875, page 902; 1880, page 1342 (historical); 1883, page 1136; 1884, page 1322; 1885, page 1477; 1886, page 1340; 1887, page 1444; 1889, page 1588; 1890, page 1824, and 1891, page 1950.

The report for 1880 gives a synopsis of plans for improving navigation at the falls, including the earliest work by the State, State Engineer Hebert's project of 1856, and Maj. Howell's report upon locks and movable dams in 1875. The last contains an estimate of $18,400 for concrete slab revetment possibly required on the Alexandria front below the Lower Falls, by reason of the change of current caused by Bailey's Dam (May, 1864). Bailey's map was made from De Russy's survey of 1859 and 1860, and shows the same error of about 800 feet along and 400 feet across the channel in the first half mile above Alexandria. De Russy's map was made for a State commission, and some work was done at the lower falls, which was regarded as an injury rather than a benefit. Maj. Benyaurd submitted an estimate of $40,000 for a cut through the Upper Falls about 75 feet wide, to give 4½ feet at a stage corresponding to low water of 1874, about 2 feet below zero of the present gauge at Alexandria. No action was taken on any of these projects till 1882, when bids were received for a modified cut at the Upper Falls, at $10.93 and $3.45 the cubic yard, and a contract at the latter price made with E. P. Doherty, of New Orleans, who hired Rittenhouse Moore, of Mobile, to do the work. The work was ill done and dragged along until the contract was closed by direction of the Chief of Engineers November 25, 1885. The amount of excavation was reported as 7,630¼ cubic yards, most of which was put into the stone dikes on the right bank at the Lower Falls, to close a channel which had cut through the bank on that side of the river. The channel at the Upper Falls was laid out with a bend about the axis of the new railroad bridge, and was left in a ragged shape both in width and depth.

* * * * * * *

The act of July 5, 1884, provided $15,000 for "revetment to protect the harbor at Alexandria from damage by the current of the river," and Maj. Miller submitted a project for a revetment from Bayou Rapides downstream 3,000 feet, at $5 the linear foot, which was approved by the Chief of Engineers July 26, 1884, but on planning to lay out the work the officer in charge was met with a demand of $5,500 from the riparian owners for the amount of bank that would have to be graded away for the revetment; or, in other words, for compensation for the privilege of being protected by the United States. Capt. Bergland, finding that "the citizens of Alexandria were anxious that something should be done for the protection of the bank" before the next high water, submitted as a makeshift substitute a high wing dam and training wall about 500 feet long, crest about 10 feet above zero, or, say, 14 feet above lowest water. This work was begun in the fall of 1884, but was interrupted by high water and not finished till December, 1885, costing the full amount of the allotment, though shorter than planned.

* * * * * * *

If there were funds available I should lay great stress on holding up the low-water slope from some point below Alexandria and distributing the drop in the water surface over the lower falls back as far as possible, by putting in a number of sills across the river to raise the bottom to about 8 feet depth at extreme low water. At present the lower falls can not be passed by upstream boats at low water, except by lines and capstan power to help the engines.

However, as the Department may be unwilling to invite litigation, I submit the following substitute for revetment: Pile work being out of the question, and the crib dikes very expensive as well as objectionable, I propose a stone dike from the training wall to the foot of the bank at Beauregard street on the line AB on the maps.

The dike to be 4 feet wide at the top, which should be at the level of gauge zero, say 4 feet above the lowest stage. The dike must be about 1,100 feet long, and with natural slopes will require about 7,000 cubic yards. This dike is suggested by the rock along shore near B, which is at zero, and behind which the bank does not appear to have caved at all. This dike is intended to form a footing, so that if the bank slides or caves it will not wash away, but gradually assume a permanent slope, while the space behind the dike will gradually fill by deposit in time of flood. Spurs may be run out from the bank at intervals of about 500 feet to hasten the fill. This dike will not cause undue scour, but tend to direct an even flow in a channel parallel to it, somewhat more nearly the center line of the reach, and will not interfere with any plans that may be adopted hereafter for the general improvement of the river.

To get the rock for this dike I propose to improve the channel at the upper falls, not by increasing the section unduly, which would not be warranted by the discharge at extreme low water, but by easing the approaches at each end of the cut, as shown by the lines on the map above and below the bridge. At present the channel is very ragged and difficult in low water, especially for downstream boats. When the Alexandria gauge reads minus 1 foot the fall from the bridge to the gauge is 2.3 feet, about one-third of which is at the passage of the lower falls, so that downstream boats, in avoiding the rocks on the starboard above the bridge, tend to flank over on the rocks on the port side, and before the pilot can straighten they are carried over towards the rocks on the starboard below the bridge.

This work can be done to best advantage in the order numbered on the map. The excavation will give about 11,000 cubic yards, which should be deposited as follows: (1) In the dike A B; (2) on the line of the old dam (found December 4, 1891, and supposed to be one of Bailey's) above the bridge, to compensate somewhat for the excavation and hold up the upper pool; (3) in the gaps between the left bank and Bailey's dam and the breaks in the dam; (4) in extending the dike on the right bank at the lower falls, as indicated on the map. The opening at the lower falls should be included also by cutting off about 50 feet from the channel end of Bailey's dam. Lastly, the crib dike and training wall should be filled wherever needed to the same height as the dike A B, and after a year or two it should be cut down to the same level if possible.

I examined the rock at the upper falls during the extreme low stage of December, 1891, and found it to be a siliceous marl rather than stone. The bridge contractors found no difficulty in drilling holes 9 feet deep with ordinary jumper drills, and I believe it can be bored even more easily with $1\frac{1}{2}$ to 2 inch ship-augers. Medium grade dynamite, in small charges, would probably be the best to break the rock for dredging, which could be determined by a few experimental shots.

The dredge *Lone Star* has been fitted with steel-pointed spuds and a heavy steel lip on the dipper, for which steel teeth have been bought. The snag-boat *Florence*, of good power and light draft, can be used for towing, and the only plant needed will be scows for carrying the rock.

Dump scows can not be used for this work at low water, so that it will be necessary to buy or build flat scows for the purpose. It happens that the Union Bridge Company has at Alexandria a number of scows used in building the bridge at the falls, which are for sale at a low figure, and are just suited for this work. The largest one, double hulled, 80 by 12 by 3 feet, hulls 10 feet apart, connected by four 12 by 12 inch beams, could be fitted with boiler, hoisting engine, crane and grapple, and steam drill if necessary, and used to hoist the large rocks, or put on a different cut from that worked by the dredge.

I estimate the cost as follows:

Additional plant and towing the dredge *Lone Star* to and from the work....	\$2,500
Office expenses, mileage, superintendence, transportation, and survey......	1,500
Excavating and depositing 11,000 cubic yards	11,000
Total..	15,000

The work should begin when Red River has fallen to 10 feet on the Alexandria gauge, with the probability of continuous low water, say between +5 and —4 feet, the drilling and boring to be at the lowest stage. The time estimated is three months if not interrupted by floods, and the price \$1.36¼ the cubic yard in the dykes, or \$1 the yard for excavation, as against the contract price of \$3.45 (or actual unknown cost), plant and superintendence not included.

It will be more economical to do the work by hired labor and purchase in open market than by contract, both because I believe I can do it better and because there can be no charge for demurrage if the work should be stopped by intermittent or continued high water, and, finally, because the work can be laid out so that if it should be found to cost more than the estimate a less amount can be done, while whatever is done will be an actual improvement.

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The foregoing project was modified by the division engineer and approved, as follows:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 10, 1892.

CAPTAIN: Your letter of March 1, 1892, submitting project for the expenditure of the $15,000 appropriated by the river and harbor act approved September 19, 1890, for work on the Red River at Alexandria, La., has been received at this office, with the following indorsement of the division engineer:

"NEW YORK, *March 5, 1892.*

"Respectfully forwarded to the Chief of Engineers.

"I fear that the prolongation of the wing-dam by the dike, marked A B, rising only to zero of the gauge, will not protect the bank of the town behind it; and recommend that the dike A B be omitted, and that the bank be protected by a thick layer of stone placed directly upon it, rising to at least half stage, or to a higher level where the slope of the bank above is less steep than the natural slope of the stone.

"Where the bank slope is nearly as steep as stone will stand, the thickness of the stone at top of the revetment should be at least 2 feet.

"The revetment should begin behind the wing dam, where the bank is safe, and extend as far towards B as funds will permit.

"To avoid land damages grading might be omitted.

"Subject to these remarks the project is approved."

The project as modified by the recommendations of the Division Engineer is approved.

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers, in charge.

Capt. J. H. WILLARD,
Corps of Engineers.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

The stages of the river have precluded any work under this project to the end of the fiscal year, and nothing has been done beyond certain necessary repairs of the United States dredge *Lone Star* at Shreveport, required before it can be used upon this work.

LITTLE RIVER FROM THE SCOPINI CUT-OFF TO KNOX POINT.

The appropriation for improving Red River by act of September 19, 1890, provided an allotment of $20,000 for "deepening and widening that portion of the river known as Little River, from the Scoping [Scopini] Cut-off to Knox Point." This stretch, extending from Tones Bayou down to Knox Point, Louisiana, originally was 21½ miles in length, but was shortened about 4 miles by Waterloo Cut-off, made in 1889, and Young Point Cut-off, made in 1890; the distance at present between Scopini Cut-off and Knox Point being 17.6 miles.

In submitting my project of September 25, 1890, for the expenditure of the general appropriation for Red River, I referred to the allotment for Little River as follows:

This was not recommended by me, and I am at a loss to account for it. I have just been through the 44 miles of Red and Little rivers below Shreveport, La., and have to say that Little River is generally the deepest part of Red River now and should not be widened for the present. It would not be an economical use of the funds to begin extensive operations in this part at once, but rather to work intermittently with the snag boats for a season. It is better to wait somewhat longer for the closing of outlets, as at Waterloo and Magenta, by natural fill, and to leave Tones Bayou open for a year or so longer. If a snag boat is sent over the line and works on the bottom logs, which are in nests and wrack heaps, and then waits for a rise and fall, the bottom will scour and disclose other logs that can be removed to

greater advantage then than by continuous work. It is this method of working that has made so great an increase in the depth of Little River. The cut through the Waterloo Neck is now sufficiently deep and wide, and the old river outlet is filled up considerably above low water, with only a narrow stream that a man can jump over. If this is left alone till next flood it probably will be filled bank high and give foundation to the State levees now projected across it. The lower end is filling, though not so rapidly, and will afford a good place for depositing snags. Again, as to widening, if we begin cutting into the banks, the appropriation will not be large enough to pay for alleged land damages. (Referring to demands at Alexandria.) I should prefer to mattress some of the bends to fix the line for Red River, and wait for natural enlargement in the reverse points below. The best argument for delay, however, is to be found in the fact that the New Orleans and Shreveport boats have been running Little River on regular time this season (1890) with 2 feet on the gauge at Shreveport, a condition unknown before to any of the pilots whom I questioned when inspecting the river last week. It is my opinion that the improvement is due not only to the work at intervals of the snag boats in the Little River, but also to the concentration of discharge by the State levees, which, in general, held out against the last flood and scoured the bottom. It is a fact that the Shreveport gauge registered last May (1890) the highest flood known, while plantations below, overflowed in former years at lower stages, were above flood this year. More water came down the river and both found and made a larger channel. With this experience it is probable that Tones Bayou can be effectively closed in a year or two without danger of destruction.

I recommended a survey and reconnoissance of the Little River, to connect with the survey of Red River and to recover former surveys, if possible, and made another inspection of the river in December, 1890, accompanied by Col. C. B. Comstock, Division Engineer, who advised taking as many sections as circumstances would permit to accompany the map. On March 8, 1892, I transmitted to the Department, through the Division Engineer, a map, sections, profile, and hydrograph of the stretch of Little River, with the following recommendations for the expenditure of the allotment, viz:

First I invite attention to the hydrograph herewith. This is made up like that submitted with the Cypress Bayou report; the limits of high and low water were drawn by connecting the elevations of such points as I had when I prepared the hydrograph of Red River for the Annual Report (1891). The low-water lines above Shreveport were obtained afterwards, when we had succeeded in finding benches of Maj. Howell's survey, and by searching through the notebooks of later date below Shreveport, those of 1884 were connected with the main line of precise levels. The hydrograph shows that the bottom of the river above Shreveport has scoured since the raft was removed and that the low-water line has fallen several feet. It indicates that the same conditions prevailed below Shreveport, though perhaps in a less degree, and that the gradual intermittent work in Little River has enabled the river to scour the bottom as the logs have been removed. It shows also by the drop in the actual high-water line (obtained by leveling to high-water marks of 1890, obtained, as stated in the report upon Cypress Bayou survey, by coöperation of planters living in this section) below the limiting line above, that a great amount of water must have escaped into the Bayou Pierre Basin. This gives another proof of the wisdom of waiting somewhat longer before closing Tones Bayou. I may add that if the work below Scopini Cut-off is carried on as proposed, it may turn out unnecessary to close Tones Bayou at all, for if the depth of the main river is increased the old river may fill up more rapidly by reason of the reduced current.

Taking the line of low water of 1884, as shown on the hydrograph, and making a reasonable allowance for a drop at least equal to the fall of low water at Shreveport below zero, about half a meter, I have drawn a line through the corresponding points on the profiles, which is sufficiently near to the probable low water throughout the whole of Little River for a base, and have drawn another, parallel to and 2½ meters below it, for the working line, which is put on the sections also. The lower line intersects the bottom line of the channel and shows where work is most needed. These points are put on the map, and will be used for guidance in prosecuting the work, actual soundings showing where to begin to best advantage.

Following the practice of getting the best results with economy, I should send the snag boats over the line at a moderately low stage, and repeat at short intervals during low water; and at certain places, as at Scopini Cut-off, and at others where the bottom may be a resisting clay, I should put the dredge at work and make one or more cuts about 2 meters deep, depositing the material in the cut-off bends, as in Old

River near by, or in the deep holes in the main river. Raft and logs may be put in the mouths of outlets like Tones Bayou with advantage. The dredge works should begin at the points where the bottom line shows highest and should continue as long as found desirable, but the snag boats should work to start up the logs only, returning from time to time when convenient or necessary. The work should spread over at least two seasons to get the best results, and gauge observations should be made at the high and low-water periods to note change in the high and low water lines.

There will be required at least two dump scows of about 80 cubic yards or less capacity, which will cost about $3,000 each delivered at Shreveport, as estimated from the cost of those built by Capt. Kingman at Simmesport. These should be charged in part to the general appropriation for Red River, part to Little River, and part to other works on which they may be used. The cost of running the dredge will be about $750 the month, and of the towboat about $900 the month, with about $200 the month added for inspection, examination, and office charges.

After the work has been carried through one season an examination should be made to decide upon closing Tones Bayou, either wholly to form part of the State levees, or with low sills. There are two other shoal places above Scopini Cut-off, notably, Chalk Level, which may be helped by inexpensive wing dams, sheet piling, or mattress cribs filled with earth in sacks. No heavy or permanent work will be required, in my opinion; at least none should be proposed at present. As far as possible, no permanent work should be thought of till the question of the general improvement of Red River can be discussed intelligently by the aid of the results of the survey. My present opinion is that revetment should play the principal part in any plan for improving the navigation of Red River, and that it is very desirable to hold the river to the lines selected for it, especially in the raft region above and below Shreveport, but it is out of the question to begin any such work in the Little River with the amount allotted for that part.

* * * * * * *

It is to be regretted that the item for Little River was put into the last river and harbor bill without the recommendation or knowledge of the Department, not only because the appropriation was contrary to law, no examination or survey having been made for the work, but because it embarrasses the district engineer as well as the Department to make plans under conditions prescribed by persons unacquainted with the principles of river improvement.

The foregoing recommendations were approved, as follows:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 17, 1892.

CAPTAIN: Your report of the 8th instant, submitting project for application of allotment of $20,000 for work in Little River contained in the item of appropriation for improving Red River, Louisiana and Arkansas, from Fulton to the Atchafalaya River, made by river and harbor act approved September 19, 1890, was duly received at this office with indorsement of the Division Engineer, of which the following is a copy:

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
New York, March 16, 1892.

Respectfully forwarded to the Chief of Engineers.

Capt. Willard's proposal to carry on snagging and dredging in Little River is recommended for approval. If navigation at sharp bends is very difficult, some assistance can be given by dredging on the points.

C. B. COMSTOCK,
Col. of Engrs., Bvt. Brig. Gen., U. S. A.,
Division Engineer.

The proposal as to snagging and dredging in Little River is approved.

By command of Brig. Gen. Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Capt. J. H. WILLARD,
Corps of Engineers.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

While the project for the expenditure of the allotment for the Little River was in abeyance, from September, 1890, until March, 1892, the snag boats *Howell*, *Wagner*, and *Breck*, and the dredge *Lone Star* worked over that stretch of river with good effect under the appropriation for the general improvent of the river, and the details of their operations are reported under that head.

The work done under the project approved March 17, 1892, was as follows:

April 11, 1892, the United States snag boat *Howell*, M. B. Lydon master, ran down to Knox Point and was employed for three days in working up to the Scopini Cut-off at mouth of Tones Bayou, blowing off hard clay points with explosives, cutting heavy timber on caving banks, and removing all obstructions in sight. The boat returned to Shreveport the night of April 13, after having put the stretch in good navigable condition, though scouring rapidly. On April 23, word was received by the master of the *Howell* that some large trees had caved into the river at Mercer Place, 5 miles below Scopini Cut-off, catching drift and causing the opposite bank to cave rapidly, endangering the State levee. The caved-in trees and a side jam which had lodged thereon were removed by the *Howell* April 25, and on the way back the river was found jammed at the mouth of Tones Bayou. The drift was cleared away, and the *Howell* returned to Shreveport April 28.

Continued high water during May and June prevented any further work to the end of the fiscal year, and operations will not be resumed until the stage is low enough to permit working with economy and advantage. The flood of 1892 was reported by a planter at Knox Point, the lower limit of this reach, to have reached its highest point May 31 (1 foot above the high water of 1890).

SHREVEPORT HARBOR.

Since the removal of the raft by which the volume down the main river has been increased, the left bank opposite Shreveport has gradually receded, while a wide batture has formed along the city front. If measures are not taken soon to check this, the harbor of Shreveport will be seriously impaired, and the cost of restoring it and keeping navigation reasonably good to the river above will be much increased. The whole of the opposite bank should be revetted for a distance of at least 2,500 feet, for if the bank should cave back to the higher ground on which the levees run, it would be practically impossible to confine the flood waters to the main river, but they would escape into the low ground beyond the left bank, and not return to the river until they had filled up the country below and found their way into Lake Bistenau and Loggy Bayou. This would mean disaster to Shreveport and to the planters of Bossier Parish, and probably destruction of navigation from Loggy Bayou upstream.

The rise and fall of the river at Shreveport is about 11 meters, or say 35 feet, and the bank line needing revetment begins some 2,200 feet above the railway bridge, and includes a pocket below of about 300 feet; making in all 2,500 feet, more or less, to be graded and protected. The grading can be done with pumps used for washing snags, and if the work is done at low water the mattresses can be built of stone, put in without the use of special plant. Taking a slope of 1 on 3, the protection would average about 100 feet in width, and the cost, including contingencies, should not exceed $16 the running foot, or say $40,000 for the whole. Under favorable conditions it is probable that the cost

can be reduced, but as stone must be brought either by rail or river from a considerable distance, it is not thought safe to reduce the estimate.

The flood of 1892 surpassed all others on record in Red River, rising 1 foot above the flood of 1890 at Shreveport. An immense volume of water from the overflowed lands on the west bank above was discharged from Cross Bayou, exceeding the combined discharge of Upper Red River and Twelve Mile Bayou, the total reaching 6,400 cubic meters, say 226,000 cubic feet per second. The main current was thus forced against the east bank and caused deep caving above and at the railway bridge, throwing down the east span and abutment pier of the draw. The amount of caving can not be determined without a local survey to compare the new shore lines with those of 1890, but it is stated to have exceeded 100 feet near the bridge.

Some of the work proposed in the last report may be done during the next low water, but it will not be safe to reduce the former estimate for the whole, and it is therefore repeated in the general estimates in this report.

CLOSING THE SALE AND MURPHY OUTLET.

Before the opening of a channel through the great raft above Shreveport, recourse was had to navigation at high stages through the numerous lakes along both sides of the river, which were connected with the navigable part of the river above the head of the raft by bayous or outlets, some of which were natural and others artificial. As the raft formed upstream the lower outlets had to be abandoned for newer ones above, and if the natural connections were not of sufficient capacity for the passage of boats, they were cleaned out and enlarged, or else short canals were cut, under State charters, on which heavy tolls were exacted. The first of these canals was cut in the fall of 1861, from Red River into Simpson Lake, on the right bank, 55 miles above Shreveport, by C. M. Hervey, president of a company chartered by the State of Louisiana, and authorized by joint resolution of Congress, approved February 21,1861, to remove the Red River Raft and collect tolls for thirty years from vessels passing through that portion of the river. This outlet, however, was intended only as a means of temporary communication while work was in progress in the main river below, and was little used, as the war stopped all shipments of cotton and caused the abandonment of the project for removing the raft. Subsequently other canals were cut, viz, Alban Canals Nos. 1, 2, and 3 (the latter usually known as Stanton Slough), on the left bank, and Kountz and Sale and Murphy Canals on the right bank. Since the removal of the raft these outlets have filled up gradually with drift and deposit until but little water is drawn from the river except at high stages, but their complete closure will cause the river below to widen and scour, and incidentally protect adjacent lands from overflow.

Estimates of the cost of closing all of these canals were called for by resolution of the Senate of the United States of March 10, 1882, and were submitted by the officer in charge April 4, 1882 (Report Chief of Engineers, 1882, page 1546), but no action was taken by Congress for their closure until the river and harbor act of July 5, 1884, which provided that not exceeding $5,000 of the appropriation for Red River should be applied to closing Sale and Murphy Canal.

The Sale and Murphy Canal is the uppermost of these outlets on the west, 1 mile above the head of the old raft, 66¼ miles above Shreve-

port, and 3 miles below the Arkansas and Louisiana line. Of the allotment by act of 1884, $3,213 were expended by hired labor in building a dam at the mouth of the outlet, which was commenced November 5, and completed December 4, 1884. This dam was 400 feet long, 10 feet crown, with slopes of 1 on 2, and was built to a height of 2 feet above high water, with wing levees of same height extending 60 feet from each end, but was destroyed by the first flood, the latter part of December, 1884.

No further work was authorized until the act of September 19, 1890, which directed that $5,000 of the appropriation for Red River should be used in closing the outlet. In November, 1890, a preliminary examination of the locality was made, the report upon which is contained in my last annual report (Report Chief of Engineers, 1891, page 1953), but it was decided to defer the work of construction until after the winter and spring floods had subsided and there should be a good prospect of a continued season of dry weather and low water, during which to give the structure plenty of time to consolidate and resist subsequent high water.

During the early part of the summer of 1891 operations were delayed with the expectation that the State of Louisiana would have levee work going on in the neighborhood, in conjunction with which this work might be let with greater economy and advantage, but, learning early in July that there was no certainty of any State work being done, it was not deemed advisable to defer construction longer, and July 13, 1891, a project was submitted recommending that bids be asked, by circular advertisement for fifteen days, for closing the outlet by a heavy earthen dam with wing levees at the point selected by the preliminary examination of 1890. This project was approved by the Chief of Engineers July 21. The work was well advertised August 1, by circulars posted at the post-office, Vicksburg, Miss.; post-office and wharf at Alexandria, La.; post-office, wharf boat, Cotton Exchange, and Board of Trade Shreveport, La.; and the post-offices at Fulton, Ark., Garland, Ark., Bright Star, Ark., Missionary, La., Collinsburg, La., Wild Lucia, La., and Jefferson, Tex. Forms of proposals were mailed to seven different persons, but only two bids were received, viz:

Abstract of proposals for closing Sale and Murphy Outlet, Red River, Louisiana, opened at United States Engineer Office, Vicksburg, Miss., at 12 o'clock noon August 15, 1891.

No.	Names of bidders.	*Approximate quantities of embankment.				Total.
		For the main dam, 13,000 cubic yards.		For connecting levees, 12,000 cubic yards.		
		Price per cubic yard.	Amount.	Price per cubic yard.	Amount.	
		Cents.		*Cents.*		
1	T. J. Martin and Michael Hunt*					
2	Wm. Robson & Son	30	$3,900	15	$1,800	$5,700
3	T. J. Martin and Michael Hunt	25	3,250	14	1,680	4,930

*Bid dated August 6, without guaranty. Opened and returned to bidders unread, in accordance with their written request on file, and par. 636, A. R. 1889.

The bid of Martin and Hunt was accepted August 26, and contract made with them August 31, approved by the Chief of Engineers September 26, requiring that operations be commenced by September 10

and completed by November 30, 1891. Work was begun by the contractors September 2 and completed November 25. The main dam, across the outlet, was built at the point selected for it, 1,085 feet back from the river, and is 200 feet long, 10 feet crown, and 220 feet maximum width at base, grade 2 feet above high water of 1890, inside slope 1 on 4, outside slope, 1 on 3, and contained 13,016 cubic yards of embankment. The connecting wings, or extensions, were carried on the lower side 300 feet to the swamp, and on the upper side 225 feet to the State levee. The grade, crown, and slopes of the extensions were the same as the main dam, and the amount of embankment in both was 5,096 cubic yards. Owing to the nature of the soil it was found essential to strengthen the dam and prevent washing by building a mattress of willow poles, woven in place and well ballasted with sacks of earth, terminating at bases of slopes in stout willow cribs; also to protect the ends of the wings by pile casements. After completing the dam and extensions the whole work was inclosed by a barbed-wire fence to prevent depredations by stock. I visited the outlet November 27, 1891, and inspected and received the work of the contractors, and found it to have been well done and the outlet substantially closed under the efficient supervision of Assistant Engineer John Ewens, whose report is appended, as follows:

VICKSBURG, MISS., *December 23, 1891.*

CAPTAIN: I have the honor to submit the following report on the work of building dam closing the Sale and Murphy Outlet:

* * * * * * *

In accordance with your orders a preliminary survey of the outlet was made by me November 9, 1890, the result of which survey was the selection of a site for the dam, 1,085 feet back from the bank of the Red River and about 500 feet back of the site of the old dam. The desirable features presented by this site were as follows:

1. Freedom from sunken logs and perishable material of all kinds.
2. It was the minimum section.
3. The immense barrier of drift found in front of it (at the mouth) would afford considerable protection at high-water periods.
4. The earth near it was the best in the vicinity.
5. It would never be jeopardized by a caving bank.

The calculations made for this section, which was 200 feet wide with a maximum fill of 30 feet, gave a dam of the following dimensions, viz: Crown 10 feet wide, to extend 2 feet above high-water mark (1890), with slopes inside of 1 on 4, outside 1 on 3, with extension wings at each end as far as the limit of the appropriation would allow, depending upon the prices bid for earthwork. The plans and estimates having been completed, bids for the work were opened August 15, 1891. Messrs. Martin & Hunt, living near the outlet, being the lowest bidders, were awarded the contract at 25 cents the cubic yard for earthwork on dam, and 14 cents the cubic yard for earthwork on extensions, extra allowances to be made for haul in excess of 300 feet, and for all protection work that might be required.

The work was begun September 2 and completed November 25, 1891. The contractors did the work principally with their own plantation hands and teams, which accounts for the long period it took to complete it. The work was done mainly with scrapers, although wagons were used for a few days. The season was a phenomenal one for good weather and low water, and this and the fact that the contractors employed their own teams and labor accounts for the very low price at which they did the work without loss.

The following is a description of the dam as completed: Length, 200 feet; crown, 10 feet; maximum width at base, 220 feet; slopes, inside, 1 on 4; outside, 1 on 3; grade, 2 feet above high water. Extension wing on lower side, 300 feet long; upper extension, 225 feet long; grade, crown, and slopes of extensions same as those of main dam. Elevation of top dam and extensions above Cairo datum = 234.15 feet.

The protection work was as follows: The entire surface of the dam was covered by a closely-woven willow mattress, terminating at base of slopes in stout willow cribs 4 feet wide by 5 feet deep, the whole ballasted with sacks of earth. The extensions were sodded thoroughly with Bermuda grass, the ends terminating in huge pile casements, sunk 4 feet in the ground and extending 15 feet around from the ends on each side. The entire work was inclosed by a barbed-wire fence with cypress

posts, to prevent depredations from stock and travel on the slopes; gates were provided at each end, and on lower side a roadway for wagons was built. On the upper side the new State levee connects with the wing of the dam and affords a means of getting upon the roadway across the dam. From the foregoing it will be seen that all points for strength, permanency, and protection of the dam were carefully provided for, and I think there is no doubt but it will stand the effect of the greatest flood it is possible for Red River to precipitate upon it.

The following is a tabulation of material used for and final cost of the work:

Total amount of embankment in main dam (200 feet long)	cubic yards..	13,016
In extension wings (525 feet long)	do.....	5,096
Mattress work covering dam	square feet..	27,760
Cribbing at base of dam (4 by 5 feet)	linear feet..	285
Two pile casements (8 by 15 by 76 feet)	do.....	183
Barbed-wire fencing	do.....	1,190

COST OF WORK.

Preliminary examination of site in November, 1890	$101.20
Main dam, 13,016 cubic yards, at 25 cents	3,254.00
Extra haul of part of material for main dam in excess of 300 feet	46.24
Extension wings, 5,096 cubic yards, at 14 cents	713.44
Mattress, cribs, casements, and fencing	339.99
Supervision, traveling expenses, mileage of officer in charge, telegrams, etc..	538.10
Total	4,992.97

The low-water discharge of Red River was measured at Missionary, La., 2¼ miles above the Sale and Murphy Canal, November 21, 1891, with the following results:

Width of cross section	feet..	214.6
Area of cross section	square feet..	2,012.1
Discharge per second	cubic feet..	2,288.0
Mean velocity per second	feet..	1.137
Water surface above Cairo datum plane	do...	207.456

Rod floats, run as close to bottom of river as possible, were used; float path, 200 feet long.

These measurements indicate, by comparison of the cross section of the outlet with that of Red River near it, that this outlet carried at times of high water nearly two-thirds the volume of Red River; *i. e.*, this vast percentage was deflected very suddenly from its natural course into this outlet, the damaging effect of which deflection on the regimen of the river below can not be considered too seriously.

The closing of the outlet will be of incalculable benefit not only to navigation but to the people on upper Red River as well. The Louisiana State levee board, on the strength of this work, already have begun a fine levee, extending from upper wing of the dam to the local levee, a distance of 5,840 feet, requiring 36,800 cubic yards of earth. This beginning doubtless will result in a permanent system of levees from the hills in Miller County, Ark., to Shreveport, La., a thing that would have been impossible with this outlet open. It will be safe for me to remark in this connection that, as far as the natural action of the water of the greatest flood Red River can ever possibly precipitate upon it, the Sale and Murphy Outlet is closed forever.

Very respectfully, your obedient servant,

JOHN EWENS,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers.

Under date of April 8, 1892, Mr. Henry B. Richardson, Chief State Engineer of Louisiana, informed me that what is known as the Bargetown Levee, referred to in the closing paragraph of Mr. Ewens's report, had just been completed and measured for final payment; that it extended from the Sale and Murphy Dam up to a junction with previously existing levees, about 6,088 feet in length; crown 5 feet wide, side slopes 2½ to 1, grade 2 feet above high water of 1890 (same as Sale and Murphy Dam); and contained 38,305 cubic yards of earthwork at a cost of 17 cents the cubic yard, or a total amount of $6,511.85.

During the period of high water since the closing of the outlet, it is

reported that the river below is scouring rapidly, being especially noticeable in the narrow stretch below Rush Point.

On May 10, 1892, the master of the snag boat *Howell* inspected the dam and found the flood water running around the lower wing, scouring it away. The crew of the boat cut green brush, which was packed on the dam and weighted with heavy green logs, to stop the scour and secure the dam from further damage. June 3, 1892, Mr. T. J. Martin reported that the flood of this year reached its highest point at the dam on May 27, 18 inches above the high water of 1890, the highest known before, but that neither the Sale and Murphy Dam, nor the new State levee sustained serious damage from the greatest flood ever known on Red River.

SURVEY OF RED RIVER FROM FULTON, ARKANSAS, TO ATCHAFALAYA RIVER.

This survey was begun in 1886, under an allotment of $25,000 provided in the general appropriation for improving Red River by act of August 5, 1886. Operations were suspended in March, 1887, when the funds were exhausted, field work having been carried from Fulton, Ark., down to Caspiana, La., 44 miles below Shreveport. An appropriation of $35,000 was made by act of August 11, 1888, and operations were resumed in February, 1889, and a line of precise level was run along the railroad from the Coast and Geodetic Survey bench at Delta, La., to Shreveport, La., connecting the survey with that of the Mississippi; the survey from Fulton to Shreveport was gone over, and permanent bench marks and triangulation monuments were set. From Shreveport precise levels and tertiary triangulation were carried downstream to Grand Bend, near Alexandria, La., 406 miles below Fulton; benches and monuments were placed at points selected for secondary triangulation, and a close topographic and hydrographic survey was made on the way. Field work was suspended at Grand Bend the middle of February, 1890, on account of the small balance then available, after which a small force was retained in the office to work up the notes. The act of September 19, 1890, provided $28,000 for continuing the survey, but with the exception of sediment and discharge observations between Shreveport and Alexandria and level connections with high-water marks, field work was not resumed until the early part of October, 1891, but work on the maps and notes was continued at the office. On account of the difficulties in securing skilled men for the grade of work required, and owing to the late date at which the appropriation of 1890 became available, it was deemed advisable to defer field work below Grand Bend until the following season, and this decision proved fortunate, as Red River was visited by heavy rains and kept at stages too high to permit continuous work in the field until late the following summer, and the loss in organizing and breaking up parties at intervals, or in working under great disadvantages, was avoided. The sickly season having passed, field work was resumed early in October, 1891, at Grand Bend, 10 miles below Alexandria, and was completed in February, 1892. The precise level line was closed on Coast and Geodetic Survey bench XLV at Smithland, La., completing a line 654 kilometers long, and giving a difference between the elevations obtained by the two surveys of only 0.0216 meter. Tertiary triangulation was carried down to and connected with the Coast and Geodetic Survey base at Lum Point, Louisiana. Topography was closed at the Mississippi River Commission monument near mouth of Red River.

After suspension of field work the quarter boats were moved to Barbre Landing, near the mouth of Red River, and laid up, and a small force was retained at the office and employed in computing, tabulating, and mapping the results of the survey, but as it has been impracticable to complete the tabulations, their publication will have to be deferred until next year.

The approved project for the survey of Red River contemplated tertiary and secondary triangulation between Fulton and the Atchafalaya, precise levels, permanent bench marks, gauges, and the preparation of maps for issue; the whole to be a thorough and comprehensive survey with a view to the permanent improvement of the river. It is estimated that the cost of completing the survey upon a scale proportional to the importance of the stream will be $97,000, to be applied as follows:

For 800 kilometers (500 miles) secondary triangulation from Atchafalaya River to Fulton, Ark., at $75 per kilometer	$60,000
Borings and transvalley sections at 8 stations	8,000
High and low water discharge and sediment observations and gauges	6,000
Computation and projection of maps	5,000
500 sets of maps (100 sheets each), scale 1-10000	15,000
Repairs and outfit, quarter-boats, hire of launch, skiffs, contingencies, and office expenses	3,000
Total	97,000

The report of Assistant Engineer H. M. Marshall, under whose efficient supervision the survey work has been conducted, is appended hereto.

REPORT OF MR. H. M. MARSHALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 1, 1892.

CAPTAIN: I have the honor to submit the following report of operations on Red River survey during the current fiscal year:

Discharge measurements were continued through July and August, the discharge being taken at Alexandria, La., except during ten days, when the party was transferred to mouth of Black River. The regular field party was brought together at Alexandria the first week in October, and began work at Grand Bend on the 7th. Work continued without intermission to February 4, when the party was broken up; one assistant with an observer and a small party of laborers being retained to examine the triangulation through the timbered region between Barbin Landing, on Red River, and Black Hawk Landing, on Mississippi River. More extended reference to this examination will appear later. Triangulation was carried from the last base of 1889, at Grand Bend, to the U. S. Coast and Geodetic Survey base at Lum Point, intermediate base lines being measured at proper intervals between, and connection made with U. S. Coast and Geodetic Survey station "Pullen" at Black Hawk Landing. The base at Lum Point, measured twice by Coast and Geodetic Survey in 1880, using 6-meter contact slide rods, was measured by means of Red River survey base apparatus. Field reduction of these measurments shows so close agreement with measurements of Coast and Geodetic Survey base at Delta, made in 1889, that it was not deemed needful to remeasure that base.

Precise levels were continued from Red River survey P. B. M. No. 76 along the river bank to the head of the lower river swamp country at Barbin Landing, thence the line crossed Avoyelles Prairie, ran along the bank of Bayou Des Glaizes, crossed Atchafalaya River at Simmesport, and ended on Coast and Geodetic Survey P. B. M. XLV, at Smithland, on the Mississippi River. The difference of closure of the entire loop, Smithland, Delta, Shreveport, Grand Bend, and back to Smithland, was +0.0216 meter. The length of the portion Smithland to Delta, run by Coast and Geodetic Survey, is unknown; the remaining portion was 654 kilometers, measured along the path of the levels. From Barbin Landing duplicate wye levels were run along the river bank to head of Bayou Cocodrie, and thence to Mississippi River Commission stone $\frac{1}{44}$ at Black Hawk Landing; the distance run being about 75 kilometers and the difference of closure —0.05 meter.

Topography was taken by transit and stadia, covering both banks as heretofore, particular attention being given to the feature—present and future levees.

Hydrographic measurement consisted of cross sections, channel sounding, gauge reading, and current meter observations.

Work in the office has progressed quite rapidly, but as it was not possible to tabulate all results in time for the report this year, it was determined to wait and make publication of all at once, rather than scatter the information through reports for several years. Map sheets are complete above Shreveport, except two which have not the conventional signs. Below Shreveport seventeen sheets are outlined, and on these the printing devices for putting on the signs will be used. Comparison of banks, channel, and cross sections by means of profiles from the present and previous surveys as far back as 1872, is in course of preparation.

A considerable number of high-water marks from Shreveport to the head of Atchafalaya River has been referred to Cairo datum, while but little information has been gathered concerning low-water elevations, that little being obtained as the ground work of the survey progressed. The bench marks now established along the entire river render it for the first time possible to trace the low water, its slope, and how it is affected.

High and low gauge readings, and discharge measurements, with borings systematically taken, will reveal the cause of bad navigation and lead to the proper remedy.

From the head of Atchafalaya River to Shreveport the survey is accurate, well marked by monuments quite comprehensive, and, except the hydrography, is thoroughly checked. Above Shreveport it is as good as can be without a system of triangulation and precise levels, the latter deficiency being in part atoned for by accurate wye levels carefully checked.

It is to be regretted if the original project for secondary triangulation suffers modification; but the work accomplished under your direction will remain for many years to come, and afford a correct basis on which to project a complete system of improvement.

Very respectfully, your obedient servant,

H. M. MARSHALL,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers, U. S. A.

DETAILED ESTIMATES.

Plant.

Flatboat with steam power and crane or shears, cabin, and outfit	$3,000
Pile-driver with steam hammer and jet	3,500
Small towboat and tender, steel hull	15,000
Skiffs, rigging, tools, etc	2,000

Service of plant.

Expenses of snag and towboats	25,000
Expenses of dredge	5,000
Expenses of chopping parties	7,000

Care of plant.

Wages, subsistence, and supplies for fleet	3,000
Regular and extraordinary repairs	4,000

Construction.

Repairing and enlarging the State levees by joining with the State engineers and levee boards for the purpose of confining the waters of the Red River to the adopted channel, thereby improving and giving ease and safety to the navigation of the river, cubic yards estimated as follows:		
Caddo district above Shreveport	50,000	
Caddo district below Shreveport	270,000	
Bossier district below Shreveport	300,000	
Bossier district above Shreveport	30,000	
Rapides district from Alexandria to Avoyelles Prairie	140,000	
Total cubic yards, at 20 cents	790,000	158,000
Revetment at Shreveport		40,000

Closing outlets.

Dooley and Red Bayou	$4,000
Cottonwood Bayou	7,000
Cowhide Bayou	4,000
Tones Bayou	20,000
Choctaw Bayou	5,000
Draining impounded water from Choctaw Bayou by canal to Bayou des Glaises, or otherwise	10,000

Gauges.

Establishing gauges and pay of observers	1,500
Leveling and monuments	1,500

Surveys.

Completing survey of Red River according to approved project, including triangulation, transvalley sections, borings, and publication of maps on full scale	97,000
Local surveys and examinations of caving banks for revetment work	3,500

Administration.

Office expenses, stationery, mileage, and contingencies	3,500
Assistant engineers, draftsmen, inspection, and transportation	4,000
Total	426,500

Money statement.

July 1, 1891, balance unexpended	$104,404.94
June 30, 1892, amount expended during fiscal year	61,711.81
July 1, 1892, balance unexpended	42,693.13
July 1, 1892, outstanding liabilities	107.12
July 1, 1892, balance available	42,586.01
Amount appropriated by act approved July 13, 1892	145,000.00
Amount available for fiscal year ending June 30, 1893	187,586.01
Amount that can be profitably expended in fiscal year ending June 30, 1894 / Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	426,500.00

The amounts expended during the fiscal year ending June 30, 1892, and balances unexpended July 1, 1892, are as follows:

	Expended during year.	Balances July 1, 1892.
For general improvement, repairs, care of plant, etc	$32,473.18	$10,974.49
For work at Alexandria, La	454.00	14,546.00
For Little River from Scopini Cut-off to Knox Point	645.40	17,030.61
For closing Sale and Murphy Outlet	4,889.92	8.88
For Cypress Bayou, etc		40.95
For the survey of Red River	23,249.31	92.20
Total	61,711.81	42,693.13

COMMERCIAL STATISTICS.

In the past fiscal year Red River was navigable between Shreveport and the mouth from July 1 to October 1 and from December 24 to June 30. Between Shreveport and Fulton there was navigation from September to end of June. From Shreveport to Garland the smaller steamboats ran the year round. The mouth was reported closed during October, November, and the greater part of December.

The following steamboats were engaged in navigation of Red River in the fiscal year:

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Valley Queen	410.83	190.6	35.8	5.6	2 6	8 6	New Orleans and Shreveport.	21	1,490
Garland	261.42	162.0	30.0	4.8	2 0	5 6	....do	18	324
Hallette	265.90	161.0	30.5	4.5	2 0	5 6	....do	23	473
John D. Scully	285.70	215.0	34.6	4.5	2 0	5 6	....do	7	178
C. E. Satterlee	254.49	162.0	30.0	4.5	1 8	5 6	....do	11	124
							Alexandria and Shreveport.	12	485
							Alexandria and Coushatta.	1	......
Friendly	66.76	120.0	26.6	3.3	0 11	3 0	Shreveport and Coushatta.	16	54
							Shreveport and Garland.	28	92
							Shreveport and Jefferson.	10	40
							New Orleans and Shreveport.	1	6
New Haven	92.64	136.1	24.4	3.4	2 6	4 0	....do	1	11
							Shreveport and Jefferson.	4	15
Rosa Bland	148.71	113.2	22.8	4.4	1 3	3 6	Shreveport and Coushatta.	30	550
							Shreveport and Garland.	40	550
							Shreveport and Jefferson.	12	30
							Shreveport and Mooringsport.	6	20
Blue Wing	111.82	119.0	24.0	4.2	1 8	3 6	Shreveport and Coushatta.	21	500
							Shreveport and Garland.	4	......
							Shreveport and Mooringsport.	2	30
							Shreveport and Black Bayou.	1	8
Belle Crooks	78.43	91.0	22.0	3.0	1 10	3 0	Fulton and Garland	11	57
Josie D. Harkins	73.13	110.0	19.5	3.3	1 4	3 0	(*)	....	210
Des Arc	40.88	95.0	18.0	3.0	0 6	2 6	(*)	....	175
Barge	20.00	(†)	(†)	(†)	0 6	2 0	(*)	....	......
E. B. Wheelock	254.49	160.0	30.0	4.9	1 8	5 6	Alexandria and Shreveport.	31	1,450
							Shreveport and Garland.	1	25
							New Orleans and Shreveport.	1	......
Nat F. Dortch	302.88	164.0	28.8	3.5	1 3	3 6	Alexandria and Shreveport.	15	255
							Shreveport and Garland.	16	171
							Alexandria and Coushatta.	3	2

NOTE.—All stern-wheel steamboats.
* Trip books reported lost. † Not reported.

Summary of commerce reported, with a comparison with the three years preceding.

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	29,400	21,613	18,838	12,593
Cotton seed	31,832	12,249	14,140	11,975
Cotton seed meal	....	10,000	....	....
Live stock	286	38	....	32
Hides and skins	151	212	35	97
Lumber	2,352	....	4,519	....
Saw logs	22,250	16,523	....	....
Staves	206	81	58	....
Stone	....	....	....	4,600
Miscellaneous	14,107	2,719	136	373
Total down freight	100,584	63,435	37,726	29,670
Return freight	19,942	30,051	28,650	19,780
Total	120,526	93,486	66,376	49,450
Estimated value	$6,877,000	$9,185,000	$6,820,000	$5,370,000

In addition to the above: From Ouachita River entering Red River at mouth of Black River, 101,820 tons, the value of which is estimated to be $6,680,600.

The following table shows receipts and shipments of cotton at Shreveport, La.

	1891-'92.	1890-'91.	1889-'90.	1888-'89.
Receipts.	*Bales.*	*Bales.*	*Bales.*	*Bales.*
By rail	44,256	39,890	25,476	30,331
By wagon	49,644	37,725	40,026	35,450
By river	9,189	14,836	8,897	12,368
Warehouse receipts	103,089	92,449	74,399	78,149
Shipments.				
By Texas and Pacific Railroad	36,645	23,311	23,690	20,582
By Vicksburg, Shreveport and Pacific Railroad	23,251	15,564	20,813	24,029
By Shreveport and Houston Railroad	5,353	13,860	12,529	494
By St. Louis Southwestern Railroad	24,187	15,039	8,820	24,125
By river to New Orleans	10,567	19,218	8,412	8,956
Total	100,003	86,992	74,264	78,184

The water route from Shreveport, La., to Jefferson, Tex., through the lakes and Cypress Bayou, was navigable from February 1, to June 30, 1892. The number of trips made by steamboats is given in the list above, and the freights reported were as follows:

Articles.	1891-'92.	1890-'91.	1889-'90.
	Tons.	*Tons.*	*Tons.*
Cotton	467	625	200
Cotton seed	60	200	25
Hides and skins	75	....	....
Live stock	14	....	....
Saw logs	60,075	82,400	(*)
Miscellaneous	900	1,825	....
Total down freight	61,591	85,050	225
Return freight	272	700	3,300
Total	61,863	85,750	3,528
Estimated value	$344,000	$748,000	$304,325

* Not reported.

The competing routes of transportation for the trade of the Red River Valley below Fulton, Ark., are as follows: The river is crossed by the St. Louis, Iron Mountain and Southern Railway at Fulton, Ark., by the St. Louis Southwestern Railway (Cotton Belt Route) at Garland, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Shreveport, La., and a branch of the Cotton Belt system from Lewisville, Ark., 8 miles east of Garland, runs parallel to the river to Shreveport. The Texas and Pacific Railway runs nearly parallel to the river, and touches at Alexandria, Boyce, Shreveport, and other points on the main river, and at Jefferson, Tex., on Cypress Bayou, and connects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain and Southern. Morgan's Louisiana and Texas Railroad, a branch of the Southern Pacific, runs from Alexandria to the main line. Shreveport is the eastern terminus of the Shreveport and Houston Railroad. The Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific system, crosses the river about 1¼ miles above Alexandria. The Kansas City, Watkins and Gulf Railway has completed its line from Lake Charles, La., on the Southern Pacific, to Alexandria, and another line is projected that will cross at Alexandria. Jefferson, Tex., at the head of navigation on Cypress Bayou, has transportation by the Missouri, Kansas and Texas Railway, in addition to the Texas and Pacific Railway mentioned above. The Kansas City and New Orleans Railway, projected to run about 100 miles from Kuli Juli, Ind. T., to Collins Bluff, Ark., on Red River, 80 miles above Shreveport, is in course of construction from Dalby Springs to Desboro, Tex., a distance of 7 miles.

V 2.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

An examination of Red River above Fulton, Ark., was made in 1884, in accordance with requirements of river and harbor act of that year, and the plan recommended for its improvement contemplated removal of snags and drift, etc., to secure safer high-water navigation from Fulton up to the mouth of Kiamichi River, Indian Territory (Report Chief of Engineers, 1885, pages 1617–1627). The distance from Fulton to Kiamichi River by river is about 138 miles. The estimated cost of the work was $10,000, if expended in one season's operations. In 1889 an additional appropriation of $2,000 was recommended, to be applied to going over and completing the work.

The appropriations have been as follows:

By act of—	
August 5, 1886	$7,000
August 11, 1888	3,000
September 19, 1890	2,000
Total amount appropriated	12,000

In the fiscal year 1887 the hand-propelled snag boat *Harry Breck*, fitted with steam capstan, was built at Fulton, at a cost of $4,000, for use on this improvement. During the periods of low water in 1887 and 1888 this boat was employed in removing obstructions until the funds were exhausted, after which, in December, 1888, it was transferred for temporary use in Red River below Fulton. In February, 1891, the snag boat *Breck* was sold to the work of improving Red River, Louisiana and Arkansas, for $1,500, and the proceeds of the sale were applied to removal of obstructions above Fulton, in connection with the appropriation of September 19, 1890. In January and February, 1891, the snag boats *Howell* and *Breck* were employed in going over the work, and operations of the former extended upstream to within 30 miles of the upper limit, as far as the boat was able to go on the

stage of water, and a fair steamboat channel was cleared for navigation at high stages of water, practically completing the project for this improvement.

No work was done during the fiscal year 1892.

The following extract is taken from my annual report of 1891, viz:

This part of the river is navigable for the smallest boats, and during high stages only. Lanesport, Ark., near the Indian Territory line, 74 miles above Fulton, usually is considered the upper limit of navigation, but boats make occasional trips to Kiamichi on the highest stages of river. Below the Kiamichi Red River has no tributary of consequence except Little River, which enters the main stream 2 miles above Fulton. The oscillations are so rapid, that frequently boats can run in one direction only on a single rise, and have to regulate their trips by the quantity and duration of rainfall in the upper-river country.

The banks are covered with trees constantly caving or sliding into the river, and if the removal of obstructions from the channel were continued and the timber cleared from the banks to stop further accumulations, navigation would be safer and there would be less drift to contend with in the river below Fulton, but it is doubtful if the boating period would be lengthened or the upper limit extended.

I recommend one of two courses in regard to this part of Red River; either that no further work be done in it until there shall be a pressing demand for a considerable improvement from Fulton upward, including Little River, both to gain a better and longer period of navigation and to help drain the adjacent lands; or else that a liberal amount, say not less than $10,000, shall be given in a single appropriation to allow the systematic clearing of the banks and removal of logs from the channel way to permit the bottom to scour. In no other way can the money be expended economically or any appreciable results obtained. The cost of organization and administration will be about the same for a small appropriation as for a large one, and the cost of getting the plant to the scene of operations and returning it to the fleet or other work will reach together nearly $1,000. The estimate is submitted with the idea of sending all the snag boats in Red River to work together under one management just as soon as the spring floods begin to subside, the snag boats to be employed on the wrack heaps and heavy obstructions, and the chopping parties to clear the banks, so that all loose stuff shall go out on the first and succeeding rises. This will allow about six weeks' to two months' work of the snag boats, the lightest draft boat being kept perhaps somewhat longer, and the boat with the chopping party continuing on downstream on bank work and small jams. About $1,000 should be held in reserve to send a snag boat over the whole the following season to dislodge heavy drift and pick up channel snags.

Money statement.

July 1, 1891, balance unexpended	$226.18
June 30, 1892, amount expended during fiscal year	5.44
July 1, 1892, balance unexpended	220.74
July 1, 1892, outstanding liabilities	1.29
July 1, 1892, balance available	219.45
Amount appropriated by act approved July 13, 1892	3,500.00
Amount available for fiscal year ending June 30, 1893	3,719.45
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This part of Red River was navigable in the past fiscal year for small steamboats from October to June 30.

List of boats engaged in the trade.

Name.	Class.	Tonnage.	Length	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Belle Crooks	Stern-wheel steamboat.	78.43	91.0	22.0	3.0	1 10	3 0	Fulton and Kiamichi.	41	...
Josie D. Harkins	do	73.13	110.0	19.5	3.3	1 4	3 0		*30	...
Des Arc	do	40.88	95.0	18.0	3.0	0 6	2 6		*5	55
Barge		20.00				0 6	2 0		*30	...

* The trip books of the steamers *Harkins* and *Des Arc*, and the barge were lost, so that terminal points of the trips made can not be given.

Summary of freights carried.

Articles.	1891-'92.	1890-'91.
	Tons.	*Tons.*
Cotton	1,577	774
Cotton seed	1,000	353
Lumber	300	244
Provisions	600	334
Grain	750	418
Miscellaneous		100
Total	4,227	2,223
Estimated value	$397,280	$265,000

The river from the mouth of Kiamichi, the upper limit of improvement, to Fulton, is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railroad, which crosses Red River at Arthur, Tex., above the head of navigation. The Texarkana and Fort Smith Railway crosses the river about 10 miles north of Texarkana, and the St. Louis, Iron Mountain and Southern Railway crosses at Fulton.

V 3.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Ouachita (the Indian name for black) River has its source in Polk County, Ark., in the Ouachita Mountains, and following an irregular course flows in a general southeasterly direction through Arkansas and Louisiana until joined by Tensas and Little rivers at Trinity, La. Below this junction it is known as Black River and flows in a southerly direction, entering Red River 35 miles above its mouth. The entire length of Ouachita River is about 500 miles, and that of Black River is 47 miles.

Under river and harbor act of 1870 and examination was made and a project submitted for temporary improvement from Arkadelphia, Ark., to the mouth of Ouachita by the removal of snags and dredging at the worst bars, at an estimated cost of $98,300 (Report Chief of Engineers, 1871, pages 334–346), and the removal of obstructions was commenced in 1871. A survey of the Ouachita from Camden, Ark., to Trinity, La., was ordered by act of 1871, the report on which recommended improvement by locks and dams (Report Chief of Engineers, 1872, pages 367–74),

and contract was let for furnishing timber for foundations of three locks. In February, 1873, the maps and notes of the survey were reviewed by a board, and a resurvey was ordered by the Department, which was finished in 1874. In view of the cost of slack-water navigation, as compared with the amount of commerce reported, it was considered inexpedient to go on with construction of locks and dams, and, upon the recommendation of the officer in charge, the project was abandoned and the available funds were applied to construction and operation of a snag boat and to building dikes at the shoals. The project under which work below Camden, Ark., has been carried on since 1874, contemplates the removal of snags, logs, wrecks, leaning timber, etc., and the improvement of shoal places by dams and dredging. Black River was added under the same head of appropriation with Ouachita by act of 1884. The distance from Camden, Ark., to mouth of Black River is 341 miles. No estimates of cost are given, as the nature of the work requires that it be continuous.

Since the plan of improvement by locks and dams was laid aside three examinations have been ordered, with a view to reviving the subject, but the reports agree in recommending that the project approved by the Department and adopted in 1874, and under which operations have been conducted since, should not be changed until the country is more thickly settled and an increase of trade developed to justify a large expenditure for permanent improvement.

The appropriations have been as follows:

Date of act.	Locality.	Amount.
Mar 3, 1871	Between Arkadelphia, Ark., and Louisiana State line	$25,000
Do.	Between Arkansas State line and Trinity, La	26,000
June 10, 1872	Between Arkadelphia, Ark., and Louisiana State line	60,000
Do.	Between Arkansas State line and Trinity, La	40,000
Mar. 3, 1873	Between Arkansas State line and Trinity, La	60,000
Aug. 14, 1876	Between Camden, Ark., and Trinity, La	12,000
June 18, 1878	......do	10,000
Mar. 3, 1879	......do	10,000
June 14, 1880	......do	8,000
Mar. 3, 1881	......do	12,000
Aug. 2, 1882	......do	12,000
July 5, 1884	Between Camden, Ark., and mouth Black River, Louisiana	15,000
Aug. 5, 1886	......do	17,500
Aug. 11, 1888	......do	20,000
Sept. 19, 1890	......do	15,000
	Total amount appropriated	342,500

The total amount expended to June 30, 1891 (including outstanding liabilities of $241.67), was $329,965.12, of which $216,377.25 had been applied to operations under the project of 1874. The iron hull snag boat *O. G. Wagner* was purchased for this work in 1875, and repaired with a new steel bottom in 1886. Under provision of the act of 1888, the small wooden steamer *Hooker* was purchased that year and fitted up for light snagging in Ouachita River and tributaries. From 1875 to the end of the fiscal year 1891, operations were carried on whenever funds were available for the purpose, and the work done consisted chiefly of removing wrecks, snags, logs, and tree slides from the channel and cutting leaning timber, though an increased depth was gained at some of the shoals by construction of stone and brush wing dams.

During the fiscal year ending June 30, 1892, work was continued as follows:

The snag boat *Howell*, M. B. Lydon master, which was sent to work over Lower Ouachita and Black River in June, 1891, continued opera-

tions from Logtown on the Ouachita down to the mouth of Black River, removing all obstructions that could be found, chiefly trees that had slid into the channel. The boat reached the mouth of Black River July 17, 1891, and was returned to the work of improving Red River.

The following is a summary of the work done by the *Howell*, July 1–17:

Snags pulled	129
Stumps pulled	41
Shore snags cut	50
Leaning trees cut	351

The chopping party, which commenced operations at Camden, Ark., in November, 1890, continued downstream from Miller Bluff, Ark., to Alabama Landing, La., 126½ miles below Camden, and suspended work at the latter place December 31, 1891, on account of high water. The quarter boat and outfit of tools, etc., were moved down to Monroe, La., in January, 1892, and laid up in charge of watchmen. The work of this party consisted of cutting the leaning timber into short lengths, paying special attention to the points and bends, girdling trees for some distance back from the river, and removing snags, etc., from the channel as far as practicable, with explosives and hand capstan. During the greater portion of the six months in which the work was carried on the water was at a very low stage, and, with the exception of a sudden rise in August and the prevalence of sickness among the men in September, the conditions were favorable to effective work, which was pursued to great advantage as far down as Extra Landing, Ark., near the Louisiana State line. While working near Extra Landing, December 23, a heavy rise set in and operations below to Alabama Landing, a distance of 14 miles, had to be confined to girdling trees and removing side jams. Notable improvement was reported at the following places, viz: Slim Island Bar, where the trees projected halfway across the river; Haidee Shoals, where a skiff hardly could pass at low water before the work was done, and a week was spent in removing logs, snags, and caved-in trees from the channel, requiring the use of 375 pounds of dynamite; above and below Boone Mound; at Boone Shoals, which were obstructed almost as badly as Haidee; Champagnolle Creek; Eldorado Landing, Bang and Dunn Landings, where extensive tree slides were removed from the channel; Moro Bay, Romeo Shoals, Jacks Island, and Grand Mary Point.

Overseer Burkette was relieved of supervision of the work in August, 1891, by Overseer William L. Lohmann, who resigned the position in October, on account of sickness incurred on the work, and subsequent operations were conducted under Overseer F. L. Baugh. Nothing has been done since December, as the stages have been too high for effective work. The following is a summary of the work of the chopping party for the six months ending December 31, 1891:

Location of party June 30, 1891, Miller Bluff, Ark.
Location of party December 31, 1891, Alabama Landing, La.

Distance worked over ....miles..	95
Snags, logs, and stumps removed from channel	2,392
Shore snags removed	11,318
Jams removed	3
Side jams removed	3
Leaning trees cut	76,991
Leaning trees topped	24
Trees girdled	24,543
Square yards brush and willows cut	675

Wrecks removed, viz: Part of steamer *Lottawana* (sunk 1875) lying across channel at Grand Mary Point.

A new boiler for the snag-boat *Wagner* was purchased to replace the one which burst at Shreveport May 9, 1890, and was set up in place in October, 1891. At that time it was impracticable, owing to extreme low water, for the boat to pass the bars to supplement work of the chopping party in Upper Ouachita as intended, and it was employed temporarily in Red River. The heavy rise in December, and continued high stages, in connection with the necessity for reserving a portion of the small balance available for the care and preservation of plant, prevented operating the boat since.

Nothing was done at Catahoula Shoals during the year, as the funds available were not sufficient for the work needed. A survey of the stretch was made during low water in August, 1890, and the maps and report are contained in my last annual report. (Report Chief of Engineers, 1891, pages 1967-1969.) The crossing is exceedingly difficult and grows worse instead of mending. The estimated cost of the work recommended for improvement of the channel through the shoals is $20,000, provided the entire amount be granted in one appropriation, so that operations may be prosecuted economically and without delays.

I renew the recommendations made in my reports for 1890 and 1891 (see Report Chief of Engineers, 1891, pages 1969-1972), for reconnoissance, with the view of repairing the levees on the river below Monroe, establishing and maintaining permanent gauges at important points at the mouths of the tributary streams, Bayous Bartholomew, Bœuf, Tensas, and Macon, and for an extensive survey of the whole river from Arkadelphia to Red River.

Accurate levels are of the first importance in determining the limits of high and low water, in connection with measurements of discharge at various stages, and for ascertaining the limits of the lands that might be subject to overflow in case the plan of obtaining uninterrupted navigation by locks and dams should be revived.

The estimate for the survey is low, considering the probable cost of a slackwater system, for which the most complete and accurate information is required.

Detailed estimates.

For the snag-boat service	$16,000
Expenses of chopping parties	8,000
Repairs and outfit	2,000
Dredging in Black River	2,000
Gauges, leveling, and reconnoissance	5,000
Assistant engineers and draftsmen	2,000
Survey of Ouachita River	150,000
Office expenses, stationery, mileage, and contingencies	1,500
Total	186,500

Money statement.

July 1, 1891, balance unexpended	$12,776.55
Amount received on account of overpayments in June, 1891	145.00
	12,921.55
June 30, 1892, amount expended during fiscal year	10,872.22
July 1, 1892, balance unexpended	2,049.33
July 1, 1892, outstanding liabilities	13.17
July 1, 1892, balance available	2,036.16
Amount appropriated by act approved July 13, 1892	40,000.00
Amount available for fiscal year ending June 30, 1893	42,036.16
Amount that can be profitably expended in fiscal year ending June 30, 1894	186,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

In the past fiscal year the river was navigable to Camden from November 1 to end of the year, and to Monroe, La., the whole year.

The following list shows the steamboats engaged in business on the Ouachita and tributaries during the year:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Ft.	Ft.	Ft.	Ft. in.	Ft. in.			
Ouachita	Stern-wheel steamboat.	457.45	189.0	38.0	6.5	3 6	10 0	New Orleans and Monroe.	28	1,700
John Howard	do	329.69	180.0	36.0	6.0	2 6	7 6	New Orleans and Camden.	7	80
Alto	do	363.16	166.0	34.6	4.9	2 6	6 6	do	13	196
Josie W	do	156.40	140.9	30.4	4.8	2 0	6 0	New Orleans and Monroe.	12	403
								Monroe and Lind Grove	23	94
Chas. L. Grant	Tug	25.90	63.9	12.0	5.4			New Orleans and Camden. (With raft.)	1	
Prince	Stern-wheel steamboat.	107.88	120.0	25.0	2.8	2 0	4 6	New Orleans and Trinity. (With raft.)	1	
Joe Long	do	130.22	120.0	22.0	4.4			New Orleans and Camden. (With 2 flatboats.)	1	
Harry	do	48.53	81.6	15.0	2.5			New Orleans and Bœuf River. (With raft.)	1	
Joe	Tug	18.07	44.5	10.0	4.0	3 6	5 9	New Orleans and Bœuf River. (With 3 barges.)	1	
Gen. H. F. Devol	Stern-wheel steamboat.	156.99	130.0	22.5	3.8			New Orleans and Saline River.	1	
Ferd Herold	do	900.58	244.6	34.0	7.2			New Orleans and Monroe.	4	351
								New Orleans and Ouachita City.	1	
								New Orleans and Alabama Landing.	1	
H. W. Graves	do	31.22	94.6	17.6	3.0	1 2	3 0	Monroe and Saline River.	4	150
Stella	do	80.23	83.7	18.2	8.5	1 4	3 0	Manchester and Little Bay.	17	9
Sallie	do	68.25	109.0	23.9	3.3	1 0	3 0	Monroe and Columbia.	3	200
								Monroe and Marie Saline.	1	
								Monroe and Bayous D'Arbonne and Corney.	19	
Era No. 10	do	176.89	136.0	30.8	5.0	2 0	5 0	New Orleans and Bœuf River.	1	
City of Florence	do	358.31	160.0	32.0	5.3	2 6	7 0	do	7	20
Marco	do	43.90	104.3	19.0	2.6	1 0	2 0	New Orleans and Tensas River and Bayou Maçon.	20	
Danube	do	232.32	175.0	33.8	5.1	2 0	5 6	do	25	700
Sterling White	Side-wheel steamboat.	117.09	120.0	30.5	4.2	2 0	4 6	Monroe and Bayou Bartholomew.	30	340
Parlor City	Stern-wheel steamboat.	136.30						Not reported		
Addie	do	12.54	81.0	18.0	2.0	10	2 6	Monroe and Camden	8	35
								Monroe and Alabama Landing.	17	
								Monroe and Bayou Bartholomew.	7	
								Monroe and Bayou D'Arbonne.	3	75
Marcus Collins	do	48.14	90.0	17.0	2.5	1 1	3 0	Trinity and Tensas River and Bayou Maçon.	104	150
Laura Blanks	do	62.73	104.8	21.3	3.8	1 8		Trinity and Bœuf River.	9	

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	21,890	21,433	16,652	17,788
Cotton seed	5,577	6,593	5,058	2,660
Hides and skins	7	25	36	23
Live stock	89	172	62	213
Lumber	461	16,388	7,951	5,963
Saw logs	26,880	120,000	50,000	....
Staves	23,402	17,888	21,159	8,599
Rock	....	18,000	....	....
Miscellaneous	5,197	10,856	783	1,026
Total down freight	83,503	211,355	101,701	36,342
Return freight	18,317	27,842	40,766	24,228
Total freight	101,820	239,197	142,467	60,570
Estimated value	$6,680,600	$9,130,000	$10,234,250	$8,798,000

NOTE.—The fluctuations in tonnage and value of commerce are due to the uncertainty of the logging business, which requires high water and other irregular conditions for success.

Of the above commerce the Saline River contributes 10,076 tons, valued at $229,000.

The competing routes of transportation are as follows: Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark., by the St. Louis Southwestern Railway (Cotton Belt Route), at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis and Iron Mountain Railway has a branch line parallel to the river from Camden to Gurdon, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system), connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction about midway between Bayou Bartholomew and Bœuf River, touches Ouachita River and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down parallel to the main river to Columbia, La., crossing at Riverton, 4 miles above Columbia, and runs thence to Alexandria, La. The Natchez, Red River and Texas Railroad (narrow gauge) runs from Black River Station opposite Trinity to Vidalia, La., on the Mississippi opposite Natchez. This road has a small triweekly packet running in Black River. The New Orleans and Northwestern Railway, completed from Natchez, Miss., to Rayville, La., crosses Tensas River near its mouth; and the projected extension of this road will cross Bœuf River a short distance north of Rayville, and Bartholomew near Bastrop, La.

V 4.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North, or Corney branches, near Farmerville, Union Parish, northern Louisiana; flows in a southeasterly direction, and enters Ouachita River 6 miles above Monroe, La. The course of the bayou is very tortuous, through an alluvial bottom, varying in width from 1 mile at the head of navigation to 5 or 6 miles at its mouth, which is overflowed during high water to a depth of from 5 to 15 feet. In its windings the stream touches the hills at several places, which serve as shipping points for the country back of them.

An examination and a survey, directed by river and harbor act of 1882, were made in 1883, and the project for improvement was based upon the latter. The bayou is navigable only at high stages, and it was believed that by the removal of snags, logs, wrecks, and leaning timber from Stein Bluff on the Corney Branch to the mouth of the bayou, 42½ miles, the boating season would be lengthened two months

and navigation made less hazardous at all times. The estimated cost of such improvement was $15,000 if spent in two consecutive seasons. (Report Chief of Engineers, 1884, pages 1372–1381.)

The following appropriations have been made:

By act of—	
July 5, 1884	$5,000
August 5, 1886	2,000
August 11, 1888	2,000
September 19, 1890	2,000
Total	11,000

The improvement was begun in the autumn of 1884, the first work (let by contract at a cost of $197.50 per mile), commenced at the mouth, was carried upstream about 23 miles, and suspended December 11, 1884. This work having shown that the contract method was not well adapted to the class of work required, and not the most economical means of carrying out the project, subsequent operations were conducted by hired labor. The appropriation of 1886 was expended that fall and the following summer in going over the lower 23 miles of the bayou and continuing the work upstream about 6 miles. In the summer of 1889 operations were resumed and carried up to Stein Bluff. In December, 1890, a chopping party was sent to go over the work, navigation having been reported much obstructed by fallen timber. Work commenced at Stein Bluff January 7, 1891, and was carried downstream about 9 miles, when rainy weather set in and operations had to be suspended on account of high water, and were not resumed to the end of the fiscal year.

Considerable work had been done by steamboat men in the way of clearing leaning timber and removing the worst snags before the improvement was undertaken by the United States, and in 1883 the bayou was reported navigable from six to seven months of the year. The work done by the United States extended the period of navigation fully one month, enabled boats of double the capacity of those formerly used to run in the stream to advantage and with less risk, shortened the time of trips, and reduced freight rates one half.

During the fiscal year 1892 operations were as follows:

After suspending operations in Bayou Bartholomew, the chopping party which had been employed in that stream was transferred to the D'Arbonne August 15, 1891. Operations hardly had commenced when a rise set in necessitating suspension, and the force was laid off temporarily. By August 29 the water had fallen to a favorable stage, and work was resumed. As the upper portion of the bayou was most obstructed, the quarter boat was cordeled up to Mosely Bluff, 30½ miles above the mouth, and only the worst obstructions were removed on the way. The 12 miles of bayou between Mosely and Stein Bluffs were worked over thoroughly, after which operations were carried downstream to the mouth and there suspended September 12, 1891, and the party transferred to the improvement of Bayou Bouef.

The work done consisted chiefly of cutting and girdling leaning timber, cutting stumps, shore snags, and logs along the banks, and removing snags, logs, and stumps from the channel with explosives and blocks and tackle. The bayou was at a very low stage, and all dangerous obstructions were removed. Seven large bowlders were destroyed at Crawford Bluff, which had been a constant source of trouble to steamboat men. The wreck of the steamer *Tributary* (burned 1890), which formed a dangerous obstruction in a bend of the stream, was removed entirely, and the old cut-offs were cleared of undergrowth.

Rock bars at Fish Trap Shoals and Old Mill Cut-off are serious obstructions to navigation at medium stages, but the amount available was too small to attempt work at those places.

Overseer Watkins Decker, under whose supervision operations were conducted, reported that the work done will save steamboats from three to four hours time in making the round trip to Farmerville, and enable them to run at a lower stage. He gave the following summary of work done:

Number of miles worked over	40
Snags removed from channel	1,397
Stumps removed	648
Shore snags removed	1,113
Logs removed	3,132
Leaning trees removed	3,146
Trees girdled	1,532
Square yards brush and willows cut	12,450
Large bowlders removed from channel	7

Wrecks removed, viz: Steamer *Tributary*, 94 tons, burned 1890.

The work is not permanent, as new obstructions are added from time to time, but, although the original estimate of cost contemplated completing operations from Stein Bluff to the mouth in two consecutive seasons, with the balance of that estimate ($4,000) in one appropriation the work can be done so thoroughly as not to need further attention for years.

Within the last few years navigation of the Corney Branch has been extended upstream to Cobb Landing, about 4 miles above Harris Bluff and 16½ miles above Stein Bluff, for the benefit of a growing community, embracing the towns of Shiloh on one side of the bayou and Spearsville on the other. This portion of the stream was not included in the original project, and there has been no work in it except that done recently by the steamboats aided by the shipping interest, who now ask that the project be amended for the purpose of extending operations up to Cobb Landing, the present head of navigation. The stream between Stein Bluff and Harris Bluff was included in the survey of 1884, and it was reported that it would require an entire season's operations to remove the obstructions, at a cost of $7,000, but the officer in charge considered that it would be of doubtful utility at that time. (Report Chief of Engineers, 1884, pages 1376–1381.) With the amount of that estimate, $7,000, in a single appropriation, the work can be carried from Stein Bluff up to the head of navigation at Cobb Landing and completed during one low-water season. This modification of the project appears to have received the sanction of Congress, as the pending river and harbor bill provides that of the appropriation for Bayou D'Arbonne "$1,000 shall be expended in improvement of the Corney from Stein Bluff to the head of navigation on said stream," and it is presumed that this action was based upon the report of 1884, as no survey or recommendation has been made since.

Money statement.

July 1, 1891, balance unexpended	$890.51
June 30, 1892, amount expended during fiscal year	765.45
July 1, 1892, balance unexpended	125.06
Amount appropriated by act approved July 13, 1892	4,000.00
Amount available for fiscal year ending June 30, 1893	4,125.06
Amount that can be profitably expended in fiscal year ending June 30, 1894. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	11,000.00

COMMERCIAL STATISTICS.

In the past fiscal year this bayou was navigable for eight months, from November 1 to June 30. The steamboats employed in this trade were as follows:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		From—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*			
Sallie	Stern-wheel steamboat.	68.25	109.0	23.9	3.3	1	3	Monroe to Cobb Landing on Bayou Corney.	19	200
Addie	....do	21.66	81.0	18.0	2.0	1	2	Monroe to Farmerville.	33	75

The freights reported were as follows:

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	2,610	2,738	1,500	2,500
Cotton seed		500	1,000	
Hides		4		5
Lumber (principally logs)	1,123	9,000	10,250	
Cotton-seed meal	150			
Staves	10			
Miscellaneous	668	543		
Total down freights	4,561	12,785	12,750	2,505
Return freights	1,697	1,187	1,666	1,670
Total freights	6,258	13,972	14,416	4,175
Estimated value	$617,240	$683,500	$646,000	$500,000

The bayou is the only available means of transporting crops and supplies, except by hauling long distances in wagons to the Vicksburg, Shreveport and Pacific Railroad on the south, to the branch railroad at Eldorado, Ark., or to Ouachita River.

V 5.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

Bayou Bartholomew has its source in Jefferson County, southeastern Arkansas, within a few miles of Pine Bluff, and following a tortuous course flows at first nearly parallel to Arkansas River, at a distance varying from 15 to 30 miles, then parallel to the Mississippi, at about the same average distance, but after entering Louisiana turns to the southwest and finally enters Ouachita River in Morehouse Parish, opposite Ouachita City. The total drainage area of the bayou and tributaries is about 1,800 square miles. The States of Louisiana and Arkansas made expenditures at various times for its improvement, navigation of the stream having been carried on to considerable extent as early as 1843.

Examinations of the bayou were made in accordance with requirements of river and harbor acts as follows: From its mouth to the Arkansas State line, act of March 3, 1871; from Baxter, Ark., to its mouth, acts of June 18, 1878, and June 14, 1880; and above Baxter to the Lincoln County line, Arkansas, act of July 5, 1884. Reports upon these examinations are contained in reports of the Chief of Engineers, viz: 1872, pages 383-386; 1879, pages 997-1003; 1881, pages 1453-1457; and 1885, pages 1548-1552.

The project for the improvement, adopted in 1881, contemplated the removal of snags, logs, wrecks, leaning timber, etc., to give safe navigation from Baxter, Ark., to the mouth, a distance estimated to be about 150 miles. The original estimate of cost for two consecutive seasons' work was $26,862, but as new obstructions are added every year, no estimate for permanent improvement has been made.

The following appropriations have been made:

By act of—	
March 3, 1881	$8,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
September 19, 1890	5,000
Total	33,000

The work was commenced by hired labor July 20, 1881, at Baxter, Ark., and was carried downstream to Bartholomew, Ark., where operations were suspended December 25, 1881, by high water. Operations were resumed August 29, 1882, at the latter place, and were continued downstream to Lind Grove, La., and discontinued at the latter place December 1, 1882, by high water. Owing to lack of funds nothing further was done until appropriation was made by act of July 5, 1884, when it was decided to give the contract system a trial upon this and other tributaries of Ouachita River. Contract was let for the removal of obstructions at $75 per mile, and work commenced at the mouth November 10, 1884, extended upstream 66⅔ miles, and was suspended December 7, 1884. Nothing was done the following year, as no appropriation was made, and operations were not resumed until November 20, 1886. The contract method having failed to prove satisfactory or economical to the United States, a chopping party commenced work at the mouth on the latter date and continued upstream until stopped by high water January 20, 1887, at Point Pleasant, La. Operations were resumed July 25, 1887, at Poplar Bluff, Ark., and continued downstream to Point Pleasant, and suspended at the latter place September 10, 1887, the funds being exhausted. Nothing further was done until August 6, 1889, when a chopping party commenced work at the mouth, continued upstream about 90 miles to Oak Landing, and there suspended operations November 21, 1889. In February, 1890, the United States snag boat *Hooker* made a patrol as high as Ohio Landing, Arkansas, about 118 miles above the mouth, removing jams of drift, etc. Operations were resumed last by a chopping party May 11, 1891, at Portland, Ark., about 35 miles below Baxter, and at the close of the fiscal year were still in progress and had been carried downstream about 50 miles to Hughes Place, Louisiana.

It will be seen from the foregoing that operations have extended over the entire portion of the bayou included in the project for its improvement, and that some of the worst stretches have been worked over two and three times, but at no time were the funds sufficient to do the work thoroughly and in two consecutive seasons as was contemplated. However, the intermittent work during the period of 12 years benefited navigation to a great extent. Before the improvement commenced, three months was the average duration of the navigable season; now there is better navigation for about six months, and boats of double the capacity make trips with greater safety in half the time; and the rates of freight are reported to have been reduced 50 per cent.

During the fiscal year 1892 operations were continued as follows:

The work begun by the chopping party in May, 1891, was continued

from Hughes Place, Louisiana, downstream to the mouth, where operations were suspended August 14, 1891, and the party transferred to Bayou D'Arbonne. The work consisted of girdling and cutting leaning timber, stumps, shore snags, and logs on the banks, and removing snags, logs, stumps, and trees from the channel by means of high explosives and blocks and tackle.

Overseer Watkins Decker, under whose supervision this work was done, reports as follows:

All leaning trees that were in anyway an obstruction to navigation were cut down, and all dangerous shore snags either were cut or destroyed. The removal of channel obstructions lessened the danger to navigation greatly and increased the depth of the bayou. The removal of large trees (from 1¼ to 6 feet in diameter at butt) that had caved into the bayou, forming dangerous snags or blocking the stream and catching trash and sand and thus forming bars, was of the greatest importance to navigation at low stages, and when removed the accumulation of débris washed away, leaving a clear channel with an increased depth of about 2 feet. The destruction of trees standing in the channel widened it at narrow places from 20 to 30 feet, notably at Miller Place, Townsend, the Round Bends, Haney Place, Spyker, and Fort Place. The Round Bends were worked thoroughly, the timber was cleared from the points and bends, and steamboat men will experience no further trouble there at high stages. The destruction of stumps lessened the danger of navigation greatly and increased the depth of the bayou. Many logs had to be removed before the quarter-boat could be floated downstream.

As a result of this season's work I have to say that the channel of the bayou has been widened from 20 to 30 feet, and that steamboats will be able to navigate on from 2 to 3 feet lower stage than heretofore, and I estimate that from twelve to fifteen hours time will be saved in making the round trip.

The work is not permanent, as obstructions continue to form from year to year from caving banks and falling timber, but very little will have to be done along the banks for several years. The principal work needed is the removal of logs and snags from the channel, and the coming season a light draft snag boat could be used to the best advantage for this purpose.

The planters along the bayou are much interested in its improvement, as it is of great importance to them as a carrier of their produce and supplies. Thousands of bales of cotton and tons of cotton-seed are raised yearly along its banks, and the planters wish to have a good navigable stream to compete with railroad freight rates. When steamboats stop running the railroad raises freight rates 25 per cent.

The following is a summary of the work reported:

Snags removed from channel	2,144
Stumps removed	1,323
Shore snags removed	2,832
Logs removed	7,205
Leaning trees removed	26,354
Trees girdled	13,779

It would be of great advantage to the shipping interest to have gauges at convenient points, as at Baxter or Portland, Ark., on the Missouri Pacific system, to inform steamboat men when they could enter the stream and the depths they could carry on the shoals. These stations are but 14 and 28 miles from the Coast Survey precise bench at McGehee, Ark., and would require only 31 miles of leveling to connect them with the Cairo datum.

With a gauge at the mouth of Ouachita River, the approximate limits of high and low water could be determined in one season and the probable depths at low water taken from soundings while removing obstructions. The cost of this work is insignificant compared with the information and benefits that would result. Other points might be reached by a line of levels down the Houston, Central Arkansas and Northern Railroad to Monroe, La., but the line would not be essential except for a survey of the bayou in connection with the improvement of Ouachita River. The cost of establishing two gauges, leveling, and wages for observers would fall within $500. No separate estimate is made for this

work, as it would properly be chargeable to the improvement of the stream.

Money statement.

July 1, 1891, balance unexpended	$2,246.56
June 30, 1892, amount expended during fiscal year	1,898.46
July 1, 1892, balance unexpended	348.10
July 1, 1892, outstanding liabilities	.92
July 1, 1892, balance available	347.18
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,347.18
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

In the past fiscal year this bayou was reported navigable from January 1 to June 30.

The steamboats employed in this trade were as follows:

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	Feet.	Feet.	Ft. in.	Ft. in.			
Sterling White.	Side-wheel steamboat.	117.09	120	30.5	4.2	2 0	4 6	Monroe and McComb Place 20 miles above Portland, Ark.	30	340
Addie.....	Stern-wheel steamboat.	12.54	81	18.0	2.0	0 10	2 6	Monroe, La., and Poplar Bluff.	7	....

The commerce of the stream was reported to be as follows:

Articles.	1891–'92.	1890–'91.	1889–'90.
	Tons.	Tons.	Tons.
Cotton	2,372	3,971	2,000
Cotton seed	3,326	2,467	4,000
Cotton-seed meal	1,425	516	....
Saw logs	4,450	20,080	11,839
Staves	1,648	17,822	....
Miscellaneous	410	1,340	....
Total down freights	13,631	46,196	17,839
Return freights	1,534	3,103	4,000
Total freights	15,165	49,299	21,839
Estimated value	$515,000	$826,000	$492,700

This stream is crossed at Baxter, Ark., the upper limit of improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City, Ark., runs west 56 miles to Warren, Ark., and probably will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurdon, Ark. The Houston, Central Arkansas and Northern railroad (another branch of the Missouri Pacific System) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The projected extension of the New Orleans and Northwestern Railway, north of Rayville, La., will cross Bayou Bartholomew on a line from Bastrop, La., to Hamburg, Ark.

V 6.

IMPROVEMENT OF BAYOU BŒUF (BŒUF RIVER), LOUISIANA.

Bayou Boeuf, usually called Bœuf River, has its source in Chicot County, southeastern Arkansas, flows in a general southwesterly direction, and enters Ouachita River at Stafford Point, 8 miles above Harrisonburg, Catahoula Parish, La. The improvement of this stream was undertaken by the State of Louisiana more than half a century ago, the report of the board of public works of 1840 stating that it had been opened to Point Jefferson.

An examination of this stream was made in 1880, in accordance with requirements of river and harbor act of June 14, 1880 (Report Chief of Engineers, 1881, pages 1424-1428), and the project based thereon contemplated removing snags, logs, leaning timber, etc., obstructing navigation at high stages from Wallace Landing to the mouth, a distance estimated to be about 152 miles. The estimated cost of removing the obstructions in two consecutive seasons was $20,000, but, as new obstructions are added every year and require removal from time to time, no estimate for permanent improvement has been made.

Under river and harbor act of July 5, 1884, an examination of three outlets near Point Jefferson, La., was made with a view to closing them. The report thereon recommended the closure of these outlets as necessary to preserve navigation in the stream (Report Chief of Engineers, 1885, pages 1545-1548), and this addition to the project was approved by river and harbor act of 1886, which provided $5,000 for "continuing improvement, and for closing Outlet Number One."

The following appropriations have been made:

By act of—	
March 3, 1881	$5,000
August 2, 1882	5,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	6,000
September 19, 1890	5,000
Total	31,000

The improvement was commenced, by hired labor, at Point Jefferson in August, 1881, and the work of a chopping party was carried downstream about 100 miles, and suspended at the close of November, 1881, when the available funds were exhausted. Operations were resumed September 9, 1882, and between that date and December 20, 1882, the portion of the river above the railroad crossing near Girard, La., to Point Jefferson was worked over by a chopping party. Nothing further was done until appropriation was made by act of 1884, when it was decided to give the contract method a trial upon the tributaries to Ouachita River. On Bœuf River the work was let at a rate of $75 per mile. The contractors commenced operations November 15, 1884, at the mouth, and continued upstream 60 miles, suspending work December 11, 1884. The terms of the next appropriation, by act of 1886, provided for continuing the improvement and closing outlet No. 1, but upon reëxamination it was found essential that all three outlets be closed, and, by uniting with the planters whose lands would be protected, this was done in 1887 and 1888, the proportion of cost borne by the United States having been $5,441.78. Outlet No. 1 was closed substantially, the second outlet was closed by a heavy dam, and the third by a low dam, this being all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. The removal of obstructions, by hired labor, was resumed November

8, 1888, and between that date and May 22, 1889, operations were carried from Point Jefferson to the mouth, but work was suspended from January 1 to April 25, 1889, by high water. The small balance available was expended in December, 1889, for operations of the snag boat *Hooker* in working over the 60 miles above the mouth.

The removal of obstructions between 1881 and 1889 enabled steamboats to run to Point Jefferson, 19 miles below Wallace Landing, during high stages, with greater safety.

The closure of the three outlets near Point Jefferson in 1887–'88 gave immediate benefit to navigation by confining the flow to its natural direction, and by scouring the bars below, but during the overflow from the Mississippi River, caused by breaks in the levees in the spring of 1890, all the dams were destroyed. As soon as the appropriation of 1890 became available an examination was made to determine the extent of the damage, and with a view to repairing the dams, if practicable, before high water set in. Owing to the isolated situation and the greater difficulty of obtaining earth than when the first closure was made, it was estimated that $12,000 would be required to close the three outlets and connect them with the parish levees. It being essential that all the outlets should be closed substantially, and at the same time to prevent backwater attacking the dams from the rear; the amount available having been much too small for the purpose, and inquiry having shown that no aid could be expected from local levee boards or owners of land adjacent to the outlets, it was decided to apply the available funds to the removal of obstructions, and to defer rebuilding the dams until an appropriation was made for the purpose.

During the fiscal year 1892 operations were as follows:

After suspending operations in Bayou D'Arbonne, the chopping party which had been employed on that improvement was transferred to Bœuf River. The lower part of the river being comparatively unobstructed, work was commenced September 28, 1891, at Thomas Cut-off, about 50 miles above the mouth, and carried upstream to the lower end of Tom Jones Place, 9½ miles above the Vicksburg, Shreveport and Pacific Railroad Bridge, where it was suspended December 12, 1891, a small balance of the appropriation having been reserved to remove jams of drift if found necessary. The water remained at a low stage during the entire period, and effective work was done, consisting of felling and girdling leaning trees, cutting stumps, shore snags, logs and brush along the banks, and removing snags, logs, trees, and stumps from the channel by means of explosives and blocks and tackle. Special attention was paid to clearing points and cleaning out the bends, the most notable narrow bends at which work was done being as follows: One-half mile above Big Creek, above mouth of Bayou Lafourche, Brandin Bend (one-quarter mile across at neck and 5 miles around), Dave Moore Bend, McIntosh Bend, Herbert Poe Bend, above Redmouth Bayou, Alto Bend, Kimbrough Bend, Boykin Bend, and The Kinks below the railroad bridge. The largest and most dangerous obstructions were destroyed with explosives; the smaller ones were cut into short lengths and all that could be were burned, to prevent future obstructions. An average daily force of 21 men was employed, and 2,200 pounds of dynamite were used. Overseer Watkins Decker, who supervised the work, reports that steamboats can navigate this part of the river with greater safety on any stage high enough to enable them to cross the bars, without danger of knocking down chimneys, damaging upper works, or losing cotton and other freight in leaning timber; that they can save at least thirty-six hours time on the round trip, and navigate on a 2-foot less stage than before; and that the widening

of narrow places and clearing the bends will facilitate transportation greatly by towboats with barges or rafts.

The following is a summary of the work reported:

Snags removed from channel	8,928
Stumps removed	6,372
Logs removed	25,457
Shore snags removed	11,156
Leaning trees removed	52,966
Trees girdled	13,657
Square yards brush and willows cut	20,060

The stern wheel steamer *Era No. 10*, a vessel of 176.89 tons, 136 feet long by 308 feet breadth and 5 feet depth, built in 1868, burned in Bœuf River, January 7, 1892, about 1 mile above McIntosh Place, and the wreck was a serious obstruction to navigation. A large jam of drift formed above the wreck the latter part of January and was removed by the steamer *City of Florence*, aided by Overseer Decker with explosives. It is intended to destroy the wreck under the provisions of section 8 of river and harbor act of September 19, 1890, as soon as the water reaches a stage low enough to do the work within the small balance available.

The estimates given in my last report (Report Chief of Engineers, 1891, page 1988) for closing the outlets, continuing the removal of obstructions, and for survey of Bœuf River in connection with the survey of Ouachita, are repeated, as follows:

Nor closing the three outlets near Point Jefferson	$12,000
For continuing the removal of obstructions	8,000
For survey of Bœuf River	6,000
Total	26,000

Money statement.

July 1, 1891, balance unexpended	$4,971.32
June 30, 1892, amount expended during fiscal year	4,666.39
July 1, 1892, balance unexpended	304.93
July 1, 1892, outstanding liabilities	22.54
July 1, 1892, balance available	282.39
Amount appropriated by act approved July 13, 1892	10,000.00
Amount available for fiscal year ending June 30, 1893	10,282.39
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	26,000

COMMERCIAL STATISTICS.

This river was reported navigable from January 1 to June 30, 1892.

List of steamboats engaged in navigation during the year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Ezra No. 10	Stern-wheel steamboat.	176.89	136.0	30.8	5.0	2 0	5 0	New Orleans and Easons Ferry.	1	...
City of Florence.	...do	358.3	160.0	32.0	5.3	2 6	7 0	New Orleans and railroad bridge.	5	20
								New Orleans and Easons Ferry.	2	
Laura Blanks	...do	62.73	104.8	21 3	3.8	1 8	......	Mouth of Bœuf River and Easons Ferry.	9	...
Irwin	Tug	6.72	47.0	12.2	5.0	2 2	2 2	Stafford Point and Prairie Landing.	80	50

Summary of freights reported.

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	1,583	1,760	1,397	1,084
Cotton seed	1,178	716	731	834
Hides and skins	50			
Live stock	19			
Lumber	1,352			
Saw logs	1,223			
Staves	3,138	1,777	263	54
Miscellaneous	72	179		91
Total down freights	8,615	4,432	2,391	2,063
Return freights	1,370	3,458	1,594	1,376
Total freights	9,985	7,890	3,985	3,439
Estimated value	$501,000	$636,500	$580,850	$457,100

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the projected line of the New Orleans and Northwestern Railway will cross about 1¼ miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a new line is projected (Louisiana, Arkansas and Missouri Railroad), which will touch the river at several points on the east.

V 7.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

Tensas River has its source in Lake Providence, in northeastern Louisiana, within 2 miles of the Mississippi River, flows in a general southerly direction, gradually diverging from the Mississippi, and joins Ouachita and Little rivers at Trinity, La., in forming Black River. Bayou Maçon was united under the same head of appropriation with Tensas River by the act of 1884. This stream rises in Desha County, southeastern Arkansas, near the source of Bœuf River and a few miles west of the Mississippi, flows in a general southerly direction west of and nearly parallel to the Tensas, and enters the latter about 40 miles above its mouth.

In accordance with river and harbor act of June 14, 1880, examinations of both streams were made in 1880, upon which the plan for their improvement is based. The project contemplated removing snags, logs, and leaning timber obstructing navigation; in Tensas River, from Dallas, La., to its mouth, about 134 miles, at an estimated cost of $23,000; and in Bayou Maçon, from Floyd, La., to its mouth, about 98 miles, at an estimated cost of $17,000. (Report Chief of Engineers, 1881, pages 1457-1467.) The estimates were based upon calculations for continuous work in one low-water season, and, in view of the appropriations heretofore made, are without value, as new obstructions are added every year and require removal in the interest of safe navigation from time to time.

The following appropriations have been made:

By act of—	
March 3, 1881	$3,000
July 5, 1884	4,000
August 5, 1886	4,000
August 11, 1888	5,000
September 19, 1890	5,000
Total	21,000

The improvement of Tensas River was commenced by hired labor in September, 1881, at Dallas, La., where the Vicksburg, Shreveport and Pacific Railroad crosses the river; work was carried downstream to near Buckner Place, and suspended the later part of December, 1881. The next work was let by contract at the rate of $125 per mile; operations commenced at the mouth October 29, 1884, were carried upstream about 29 miles, and suspended November 28, 1884. As the contract method failed to prove satisfactory or economical for the class of work required in these streams, subsequent operations were conducted by hired labor. As no work had been done in Bayou Maçon, the appropriation of 1886 was applied to that stream. Operations commenced November 14, 1886, and were suspended the latter part of January, 1887, the work during this period having extended from Floyd to the mouth of the bayou. In October, 1887, this work was gone over from Floyd down to Oakley, about 22 miles above the mouth, operations consisting chiefly of the destruction of accumulations of drift, most of which was burned. Work was next resumed February 1, 1889, and continued until April 22, 1889. Operations during this period extended over the entire portion of Bayou Maçon included in the project and about 25 miles of Tensas River between Mound Bayou and Tensas Bluff.

The total amount expended to June 30, 1891, was $15,873.24, of which $7,529.25 were applied to improving Tensas River and $8,343.99 to the Maçon. The obstructions were removed, as far as practicable with these amounts, and resulted in reducing the danger of navigation in these streams and shortened the time of trips about 12 hours.

During the fiscal year 1892 operations were as follows:

After suspending work in Bœuf River, the chopping party, which had been employed on that improvement, was transferred to Bayou Macon. After starting the quarter boat down Bœuf River, Overseer Watkins Decker and 4 laborers proceeded by rail to Delhi, La., and thence to the wreck of the steamboat *H. J. Dickey* (208 tons), which sank in Bayou Maçon, about 3 miles above Delhi, January 15, 1891. The destruction of the wreck had been ordered under section 8 of river and harbor act of 1890; the owners and underwriters had been notified, and ample time was given them to save the cargo and machinery. The overseer reported that upon arriving at the wreck it was found that the boilers, all the machinery except two engines and the shaft, and about half the cabin, had been removed. The boat lay across the stream, with its head high and dry on the left bank and the stern about 15 feet deep in the water on the opposite side. Charges of dynamite were placed 15 to 20 feet apart the entire length of the boat December 16 and 17, 1891, by which means the hull and remaining portion of the cabin were destroyed or broken into short pieces to float away when the water rose. The engines and shaft lie on the bottom, where they were thrown by the explosion, and can be removed only with heavy hoisting apparatus or destroyed with explosives at extreme low water, but will not interfere with navigation at the stages on which boats run in this stream. The entire cost of destroying the wreck was $95.33.

The main party, on the quarter boat, left Girard, La., Bœuf River, December 14, and reached the mouth of Bayou Maçon December 29, 1891. The bayou was at a very low stage, about 2 feet above low water, but rising slowly, and was found to be badly obstructed at that stage with channel snags, logs, stumps, and shore snags. Work consisted chiefly of removing obstructions in the channel, and was carried from

the mouth upstream a distance of about 40 miles to the Stone Place. Stormy weather set in January 12, and the bayou rose so rapidly that operations could not be pursued to advantage, and January 13-21 the boat was moved from the Stone Place upstream to the railroad bridge near Delhi. On the latter date the crew was discharged and the boat and outfit were laid up to await a favorable stage for resuming work.

The following is a summary of the work done December 16 to January 12, viz:

Snags removed from channel	875
Stumps removed	1,512
Shore snags removed	1,450
Logs removed	1,332
Leaning trees cut	1,076
Trees girdled	810

Wrecks removed, viz: Steamer *H. J. Dickey*, sunk January 15, 1891, 3 miles above Delhi, La.

On account of breaks in the Mississippi River levees near the headwaters of the Tensas and Maçon, the escape water from which found an outlet through these streams, the stages remained high to the end of the fiscal year, and nothing further could be done. As soon as the water is low enough to work to advantage, operations will be resumed and continued until the available funds are exhausted.

Gauges should be established on both of these streams on the line of the Vicksburg, Shreveport and Pacific Railroad, both to ascertain their rise and fall and to give information to steamboat men. The cost of the service should not exceed $200 a year for each gauge. A gauge at the bridge of the New Orleans and Northwestern Railway across Tensas River at Daniels Ferry would be useful, and could be established and set to Cairo datum at a cost of about $20.

Money statement.

July 1, 1891, balance unexpended	$5,126.76
June 30, 1892, amount expended during fiscal year	2,107.40
July 1, 1892, balance unexpended	3,019.36
July 1, 1892, outstanding liabilities	.38
July 1, 1892, balance available	3,018.98
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	8,018.98
Amount (estimated) required for completion of existing project	14,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

These streams were reported navigable for large boats during fiscal year, from December 1, 1891, to June 30, 1892, and for the small steamboats there was navigation the whole year.

List of stern-wheel steamboats engaged in navigation of Tensas and Maçon during fiscal year 1892.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
		Feet.	Feet.	Feet.	Ft. in.	Ft. in.			
Marco	43.90	104.3	19.0	2.6	1 0	2 0	Tensas Lake and Floyd, and Tensas Lake and Jordon, on Upper Tensas.	20	....
Danube	232.32	175.0	33.8	5.1	2 0	5 6	New Orleans and Warren on Bayou Maçon and New Light on Upper Tensas.	25	700
Marcus Collins	48.14	90.0	17.0	2.5	1 1	3 0	Trinity and Tensas River, and Bayou Maçon.	104	150

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	Tons.	Tons.	Tons.
Cotton	3,762	2,760	1,527	2,750
Cotton seed	4,876	4,850	2,920	4,000
Hides and skins	....	10	2	5
Live stock	10	6	....	225
Staves	71	1,032	3,325	3,500
Lumber	440	....	....	....
Miscellaneous	1,942	378	50	1,823
Total down freights	11,101	9,036	7,824	12,303
Return freights	5,886	6,000	5,216	8,202
Total freights	16,987	15,036	13,040	20,505
Estimated value	$990,000	$999,500	$742,390	$1,194,100

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La., and the Tensas River at Dallas, La. The New Orleans and Northwestern Railroad crosses Tensas River near Daniels Ferry, Concordia Parish, La.

V 8.

IMPROVEMENT OF BAYOUS RONDEWAY AND VIDAL, LOUISIANA.

Bayous Rondeway and Vidal form a drainage canal for the lowlands between the Tensas and Mississippi rivers in the vicinity of Lake Palmyra, an old channel of the Mississippi around Davis Island, 23 miles below Vicksburg, cut off in 1867. Bayou Rondeway joins Tensas River near Dallas, La., and, tending in a general southeasterly direction, was connected artificially with Lake Palmyra, about 8 miles from its entrance into the Mississippi, by a cut known as Harpers Canal. From this point, tending in a southeasterly direction, the name is changed to Bayou Vidal, which forms a connection with the Tensas through Mill Bayou.

In accordance with the river and harbor act of August 2, 1882, an examination of these streams was made in 1882, and in view of the cost of the work and the small amount of commerce to be benefited, the offi-

cer in charge reported adversely on their improvement. (Report Chief of Engineers, 1884, pages 1347-1351.)

Further examination was required by river and harbor act of August 5, 1886, and was made in the spring of 1887, when it was learned that the State of Louisiana intended building a new levee, which would cut off these bayous entirely from the Mississippi, and they would receive water from the Tensas only when it was high, and run dry in low water. It was recommended, however, that $1,000 be expended in removing obstructions, chiefly leaning trees, from the canal and that part of Bayou Vidal remaining open between Lake Palmyra and the line of levee north of the lake. (Report Chief of Engineers, 1887, pages 1497, 1498.)

The river and harbor act of August 11, 1888, appropriated $1,000 for this purpose, which was expended during the fiscal year 1889 in carrying out the project. After completion of the work the canal was claimed as private property, and the owner issued notice that toll would be collected on freights passing through. This canal or cut was made, before the old levee system along the west shore of the bend broke down, to connect Bayou Vidal with Lake Palmyra for the purpose of draining the swamp above, and of late years has been used for the navigable route from the lake into the bayou, the old line of the bayou having become obstructed by fallen timber and stumps. In my annual report for 1889 I recommended reopening the old bayou to save the steamboat interest from the imposition of the tolls exacted. The act of September 19, 1890, appropriated $1,000 for this purpose.

As the work could be done at low water only, it was deferred until the Mississippi reached a low stage. Operations were commenced June 22, 1891, and completed July 31, 1891, and consisted of the removal of snags and logs and felling leaning timber. All the trees were cut into short lengths and the tops trimmed, so that they could be run out of the bayou easily at high stages. The work was conducted under the supervision of Overseer W. V. Hall, and the following summary was reported by him:

Snags and logs removed from channel	146
Leaning trees cut	956
Square yards brush and willows cut	240

This work completed the project for the improvement, and nothing further is recommended for the present.

Money statement.

July 1, 1891, balance unexpended	$883.98
June 30, 1892, amount expended during fiscal year	882.87
July 1, 1892, balance unexpended	1.11
July 1, 1892, outstanding liabilities	.69
July 1, 1892, balance available	.42

COMMERCIAL STATISTICS.

There is navigation for small steamboats in Lake Palmyra, to New Carthage, at mouth of Bayou Vidal, except at lowest stages of the Mississippi River. During high water these boats run into Bayou Vidal to Kouns Landing.

List of stern-wheel steamboats engaged in navigation during fiscal year 1892.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
L. H. Sargent	85.46	116.2	22.4	4.3	1 10	3 0	Vicksburg and Lake Palmyra and Bayou Vidal.	46	100
T. P. Leathers	......	220.0	40.0	6.0	4 0	7 6	Mississippi River and Bayou Vidal	2	....
Natchez	584.9	225.0	40.0	8.0	4 0	10 0	......do	1	....

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.	1889-'90.
	Tons.	*Tons.*	*Tons.*
Cotton	757	1,979	1,750
Cotton seed	675	1,684	6,000
Live stock	15	65	....
Lumber	556	428	1,000
Provisions	206	1,112	1,400
Grain	38	1,369	400
Miscellaneous	196	822	81
Total freights	2,443	7,459	10,631
Estimated value, in round numbers	$192,750	$692,950	$750,000

V 9.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

Big Black River has its source in Webster County, Miss., flows in a general southwesterly direction, and enters Mississippi River at Grand Gulf, 37 miles below Vicksburg, having a length estimated to be about 400 miles.

Under river and harbor act of March 3, 1881, an examination of this stream was made, and the project submitted for its improvement contemplated two seasons' work in clearing a channel suitable for navigation at high stages of water, by the removal of snags, logs, leaning timber, etc., from Cox Ferry to the mouth, about 130 miles, at an estimated cost of $32,000.

The following appropriations have been made:

By act of—
July 5, 1884 .... $5,000
August 5, 1886 5,000

The first appropriation was expended in 1884-'85, when a chopping party removed the principal obstructions for a distance of about 75 miles above the mouth.

The act of 1886 required that no part of the appropriation should be used until the State of Mississippi caused the bridges below the Vicksburg and Meridian Railroad to be so constructed as not to obstruct navigation. The bridges referred to were a county bridge at Baldwin Ferry, about 70 miles above the mouth; a county bridge at Ivanhoe Ferry, about 50 miles above the mouth; and the Louisville, New Orleans, and Texas Railway Bridge, about 15 miles above the mouth. The fixed railway bridge was changed to a swing bridge in 1889, in ac-

cordance with an act of the State Legislature, and the Ivanhoe Bridge was replaced by a ferry in 1887.

The river and harbor act of 1890 removed the restriction contained in the act of 1886, and authorized the expenditure of the appropriation. The project was modified to include only that part of the river below the Baldwin Ferry Bridge, and in 1891 a snag-boat and chopping party were employed on that stretch; the principal work done was between Baldwin and Ivanhoe ferries, a distance of about 20 miles.

No work was done during the fiscal year 1892.

April 4, 1892, the board of supervisors of Warren County, Miss., submitted plans for replacing the fixed wooden bridge at Baldwin Ferry with a permanent iron swing bridge, for approval of the Secretary of War under section 7 of river and harbor act of September 19, 1890. The plans were approved April 28, 1892; the work has been let by the supervisors to the Columbus Bridge Company, and probably will be completed during the season of low water this summer or fall. This will remove the last of the bridge obstructions below the Vicksburg and Meridian (Alabama and Vicksburg) Railroad Bridge.

In view of the small amount of commerce in this stream, the fact that there is no probability of an increased business for years to come, and the cost of maintaining unobstructed navigation by the removal of snags and drift and leaning timber added every year, it is not believed that any further amount can be expended profitably in continuing the work, and for this reason no estimate is submitted.

Money statement.

July 1, 1891, balance unexpended	$264.77
June 30, 1892, amount expended during fiscal year	16.00
July 1, 1892, balance unexpended	248.77
July 1, 1892, outstanding liabilities	4.96
July 1, 1892, balance available	243.81
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,243.81

COMMERCIAL STATISTICS.

This stream is navigable for small boats at high stages only. The commerce is inconsiderable, consisting chiefly of rafting saw logs and towing staves in flat-boats. During the fiscal year the river was navigable from January 1 to June 30, 1892. The head of navigation is the Alabama and Vicksburg Railway Bridge, 13 miles east of Vicksburg.

List of steamboats engaged in navigation of Big Black River for fiscal year 1892.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
J. B. O'Brien	Tug	44.49	70.8	15.2	7.0	......	......	Natchez and Big Black River	1
Joe	do	18.07	44.5	10.0	4.0	5 6	5 9	Vicksburg and Messengers	1

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.
	Tons.	*Tons.*
Cotton		13
Cotton seed		11
Lumber		2
Staves	1,499	471
Provisions		22
Grain		10
Saw logs	14,250	9,449
Total freights	15,749	9,978
Estimated value	$55,550	$72,000

The Alabama and Vicksburg Railway crosses Big Black on a fixed bridge, 13 miles east of Vicksburg. The Louisville, New Orleans and Texas Railway crosses on a swing bridge, about 15 miles above the mouth.

V 10.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River, about 173 miles long, is formed by the junction of Tallahatchee and Yallabusha rivers in Le Flore County, Miss., flows in a general southerly and then southwesterly direction, and enters Mississippi River 5 miles above Vicksburg.

An examination, with a view to the removal of wrecks of gunboats, steamers, and other obstructions placed in this river during the war, was ordered by river and harbor act of June 10, 1872, and was reported upon the following year. (Report Chief of Engineers, 1873, pages 483, 484). A further examination was made in 1874, and estimates were submitted for thoroughly clearing the river of obstructions, within a period of four years, at a cost of $120,000; a small annual appropriation to be made thereafter for maintenance of improvement. (Reports Chief of Engineers, 1874, part 1, pages 364-367, and 1875, part 1, page 522). In view of the appropriations made, this plan could not be carried out, and in 1875 the present project was adopted, which contemplates the removal of wrecks, snags, logs, and leaning timber obstructing navigation the entire length of the river, as far as practicable with the funds provided. New obstructions, caused by floods, sliding and caving banks, etc., are added from time to time, and the work should be gone over every year in the interest of safe navigation.

The following appropriations have been made:

By act of—		By act of—	
March 3, 1873	$40,000	August 2, 1882	8,000
March 3, 1875	12,000	July 5, 1884	10,000
August 14, 1876	15,000	August 5, 1886	15,000
June 18, 1878	25,000	August 11, 1888	32,000
March 3, 1879	15,000	September 19, 1890	25,000
June 14, 1880	12,000		
March 3, 1881	6,000	Total	215,000

The first appropriation was applied in 1873-'74 to the removal of the wrecks of nine vessels, sunk during the war, viz: The *Arcadia*, *R. J. Lackland*, *Golden Age*, *Glyde*, *Petrel*, *Ivy*, *Van Dorn*, *Polk*, and *Idaho*. After newspaper advertisement of 50 days, only two proposals were received, and the contract was left to the lowest bidder for the aggregate sum of $35,450. Experience gained by this work showed that the improvement could be continued much more economically by the means of a snag boat operated with hired labor, and in 1875 and 1877 the

United States snag boat *O. G. Wagner*, was employed in removing wrecks and other obstructions. In 1879 the snag boat *John R. Meigs* was built, and the principal work since has been done with that boat. The benefits to navigation resulting from the work are marked. The large number of wrecks that obstructed the river, and limited the period of navigation, many of which were sunk to prevent passage during the war, had been removed so as to present little or no obstruction, and the removal of snags, logs, leaning timber, etc., was carried on whenever funds were available for the purpose, giving steamboat navigation from head to mouth at all stages throughout the year. The total amount expended to June 30, 1891, was $201,679.72 (including $23.69 outstanding liabilities on that date), part of which had been applied to the construction of the snag boat *Meigs* in 1879, the purchase of a pumping dredge-boat under act of 1888, and to the survey of the mouth and lower river in 1890.

The available balances July 1, 1891, for improving Yazoo River were as follows:

For general improvement, act September 19, 1890	$10,380.63
For survey from Louisville, New Orleans and Texas Railway Bridge to mouth, act September 19, 1890	348.67
For pumping dredge-boat, act August 11, 1888	2,590.98
Total	13,320.28

In the fiscal year 1892 operations were continued as follows:

GENERAL IMPROVEMENT.

During July and the greater part of August the stages of water in Yazoo River were too high for work, and advantage was taken of this opportunity to make some repairs needed on the snag boat *Meigs*. The capstan machinery, which was much worn, was taken out and the parts needing repair were sent to the foundry at Vicksburg. New gearing, shafting, and frictions were made, and the boat and machinery were given a general overhauling. This work was completed and the capstan machinery fitted in place August 25, when steam was raised and the engines and machinery found to work satisfactorily. By this time the river was falling rapidly, and September 1 a crew was hired and the *Meigs*, P. R. Starr, master, left Vicksburg, entered Yazoo River, and resumed operations. Work was commenced at the mouth and continued upstream to the head of the river. Below Yazoo City, which was reached September 3, the water was almost too high for effective work, but above that place it was at a stage favorable for operations and remained low throughout the month, and the logs, snags, and stumps in the channel and on the bottom of the river were removed readily. Notable work was done at the Narrows, Armadale Bend, below Koalunsa, Montgomery, Bermuda, Silver City, Riverside, bend at Dew Drop, Blue Sack, Mulberry Grove, Winter Quarters, below Random Shot, first bend above Random Shot, Salt Point, first three bends below Eagle Lake (where 65 logs, snags, and stumps were taken out), Rosebank, Shell Bluff, and French Bend above, below, and around wreck of steamer *Mary E. Keene* (burned 1863). At French Bend 57 snags and stumps were removed, and the wreck was cleared away level with the sand and mud, giving 3 feet of water over all portions at the extreme low stage then existing. The boilers were not taken out of the wreck, as there was 7 feet of water over them. At Roebuck Lake a number of bad snags and stumps were removed from the channel. September 23 one of the main driving-wheels on capstans Nos. 1 and 2

broke and had to be sent to the foundry at Greenwood to be replaced, and during the remainder of the month work was continued with two capstans. During the month of October the *Meigs* was employed in Tallahatchee River, but returned to the Yazoo November 1 and continued work between the head and Yazoo City until November 20, after which the boat came to Vicksburg to have a burst steam pipe repaired, etc.; returned to the river November 26, and was employed below Yazoo City until December 3. During the latter period (November 26 to December 3), and at the suggestion of the Division Engineer, assistants were sent on the *Meigs* to make discharge measurements at mouths of Big and Little Sunflower rivers, Satartia, and Louisville, New Orleans and Texas Railway Bridge, after completion of which the boat returned to Vicksburg.

The following is a summary of the work done by the *Meigs:*

Snags pulled	462	Shore snags cut	55
Stumps pulled	263	Side jams removed	1
Logs removed from channel	25		

Wrecks removed: Part steamer *Mary E. Keene*, at French Bend (burned 1863), viz: Cylinder timbers, top timbers, parts of sides, deck beams, wheel-arms and buckets, hog-chain braces, part one engine, and donkey engine; clearing the wreck level with sand and mud, and giving a minimum depth of 3 feet of water over all portions at extreme low water.

The steamer *John F. Allen* and barge, both loaded with cotton, were found aground on McCormick Bar, November 2, and were pulled 800 feet into deep water.

December 12–20, I made an inspection of the river on the *Meigs*, accompanied by Assistant Engineer John Ewens. This inspection was carried to the head of the Yazoo and up the Tallahatchee to Minter City, after which the boat was laid up in Lake Centennial at Vicksburg, as nothing further could be done on account of high stages of river since and because the small balance available would not permit resumption of operations if the conditions had been favorable. To reduce the cost of care of plant the *Meigs*, snag boat *Hooker*, and pumping dredge were laid up together, and the former has been kept in serviceable condition and ready to begin work, as soon as funds are available, by minor repairs needed from time to time.

The removal of obstructions by the *Meigs* during the season of extreme low water last fall put Yazoo River in good navigable condition, but as new snags and tree slides are brought into the stream by every high water the work will have to be continued for many years.

SURVEY OF YAZOO RIVER FROM THE LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY BRIDGE TO ITS MOUTH.

The shifting bar at the mouth of Yazoo River is the most serious obstruction to navigation of that stream and its tributaries, comprising about 800 miles of navigable waterways, and the appropriation by act of 1890 provided an allotment of $5,000 to—

be used in making a survey of the Yazoo River from the bridge of the Louisville, New Orleans and Texas Railway to its mouth, for the purpose of determining in what manner the mouth of the river can be so improved as to freely permit the passage through the same at all seasons of the year of vessels engaged in the navigation of the river; and said survey shall also include an investigation into the feasibility and advantages of making a new mouth or outlet for said river, by way of Chickasaw Bayou or otherwise, together with an estimate of the cost of the same.

This survey was begun in October, 1890, and continued until high water compelled suspension, December 6. The river remained too high to resume field work until the middle of September, 1891, when the survey was completed. The maps and report were transmitted to the De-

partment February 4, 1892. The improvement proposed contemplated opening a new outlet from the former mouth of Yazoo on Old River, through the deep water in Old River, across the lowlands between Long and Barnett lakes to Lake Centennial, around the head of Desoto Island, along the front of Vicksburg, and entering Mississippi River on the channel side at Kleinston. The estimated cost of the work is $1,500,000.

My report of February 4, 1892 (printed in House Ex. Doc. No. 125, Fifty-second Congress, first session), is given below:

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 4, 1892.

GENERAL: I have the honor to submit my report upon the survey of part of Yazoo River, authorized by the act of Congress approved September 19, 1890, in the following terms:

Improving Yazoo River, Mississippi: Continuing improvement, $25,000, of which $5,000, or so much as may be necessary, shall be used in making a survey of the Yazoo River from the bridge of the Louisville, New Orleans and Texas Railway to its mouth, for the purpose of determining in what manner the mouth of the river can be so improved as to freely permit the passage through the same, at all seasons of the year, of vessels engaged in the navigation of the river; and said survey shall also include an investigation into the feasibility and advantages of making a new mouth or outlet for said river, by way of Chickasaw Bayou, or otherwise, together with an estimate of the cost of the same.

The following maps* are submitted with this report: Title sheet; index chart, scale 1-40000; six sheets of the survey, scale 1-10000; ten tracings of profiles and sections, various scales; one sheet showing changes at the mouth of Yazoo River, scale 1-6000; and one map of the Yazoo drainage basin, scale 1-316800, to be reduced to 1-400000. Attention is invited to the large sheets, which show the latest methods of mapping, in which the work of the draftsman is supplemented by the use of the mechanical processes developed under Capt. Leach's ideas by Assistant Engineer Ockerson. The methods are described in Reports of the Chief of Engineers, 1884, page 2443; and 1885, pages 2574 and 2898.

As there were three surveys of great importance in this district ordered by the same act, it was decided to organize the parties at Vicksburg and begin with the Yazoo River survey, both in order to get the best men for the high-grade work required, and also to accomplish as much of the work as possible before the Mississippi River should rise too high. The party was made up as soon as practicable after the approval of the project required by law, and put into the field under Assistant Engineer H. M. Marshall, who was familiar with the country to be examined, having been employed upon a survey of part of the district, undertaken in 1877 under Maj. T. G. Dabney. Work was continued until high water compelled suspension of operations, December 6, 1890, when the party was transferred to the surveys of Red River and Cypress Bayou.

High water prevailed until late the following season, and it was not until August, 1891, that the field work could be finished. The survey lacks complete information upon the subjects of low-water slopes and discharge, although a great deal was accomplished in those directions; and the borings which were contemplated in the estimate and project had to be omitted for want of funds. As these, the latter especially, will be necessary for final and complete estimates, it is to be regretted that the full amount of the estimate, $8,000, was not granted.

The subject of improving the mouth of Yazoo River is not a new one, and an estimate for diverting the river will be found in the report of a Board of Engineers upon the "Improvement of the harbor and Mississippi River at Vicksburg, Mississippi" (Report Chief of Engineers, 1878, pages 637-646). The cut-off opposite Vicksburg predicted in the report of Capt. (now Lieut. Col.) Suter took place in the spring of 1876, no work having been authorized to prevent the disaster. (Report Chief of Engineers, 1871.) The citizens of Vicksburg, aroused to the necessity of active work to prevent further injury and to restore the city's river front, employed Maj. Dabney, an engineer of skill and experience, to make the preliminary surveys, which are shown in the maps accompanying the report of the Board; and it was due to this work, paid for by the citizens, that the project of fixing Delta Point was adopted. From the experience gained since then in protecting caving banks, I think it safe to say that if the cut-off were threatening now, instead of an accomplished fact, it could be prevented at a reasonable cost, probably not more than that estimated by the Board for revetment and dredging.

The estimates for diverting Yazoo River ranged from $2,768,000 to $1,780,000, but I am unable to compare them with those submitted herewith, as I do not know the dimensions of the cuts nor the depths proposed. It has been commonly thought that

*Not printed.

the project for bringing the Yazoo down Chickasaw Bayou would be a simple matter, and various estimates from $30,000 to $500,000 have been published; the general notion being that after making a cut from Yazoo into the bayou the river would do the rest. Unfortunately for the theory, but luckily for the people, Congress has paid no attention to this scheme, and the present survey, if it results in nothing else, will prevent the renewal of it. If Chickasaw Bayou drained from Yazoo River toward Vicksburg, the floods of Yazoo and Mississippi long since would have cut through to the lake; but, as a matter of fact, the bottom of most of Chickasaw Bayou and those of the adjacent lakes are above the low water of Yazoo River.

The index chart gives, in a comprehensive view, the course of Yazoo and part of Mississippi River as they were one hundred and fifty years ago, together with the lakes and bayous between these rivers and Vicksburg; and the detail sheets give the elevations above the absolute reference plane of the Mississippi River Commission and Engineer Department, the Cairo datum, which is 6.36 meters (about 21 feet) below mean Gulf level at Biloxi. The main levels were run with great accuracy by the method of precision, beginning with Bench No. 215 of the Coast and Geodetic Survey at Delta; and the triangulation depends upon the permanent points of the Coast Survey at Vicksburg and Delta. The metric system has been used throughout, both for elevations and distances, and in calculating quantities, etc., and the estimates submitted are made up from the cost of work similarly situated, the experience of the Mississippi River Commission being largely depended upon.

It is proper here to express satisfaction with the work of all engaged on the survey, official credit being given them by putting the names of the assistants with their duties upon the title sheet. The report of Assistant Engineer Marshall, who had direct charge of the survey in the field and of the investigations and computations in the office, is appended herewith, to which reference may be had for details, estimates, etc.

The first thing to be discussed is "In what manner the mouth of the river can be so improved as to freely permit the passage through the same, at all seasons of the year, of vessels engaged in the navigation of the river." I do not believe this can be done even by throwing the Mississippi River from the right to the left bank, so as to wash the present mouth away and cause the Yazoo to enter once more upon the bend or channel side, as once it did when the Mississippi ran in the bend shown on the map as Old River. There can be no doubt that some time in the last century a cut-off took place, and that for some years before the Mississippi River ran in long bends above and below the present site of Vicksburg, much as it does now above and below Greenville; and during that time Yazoo River entered Mississippi on the bend in deep water, where now it joins Old River. Old River and the wrong end are still deep, and the convex bar has not changed except to tail down toward the present mouth of Yazoo instead of down the wrong end of Old River, the former direction of Mississippi's flow. When a cut-off takes place the banks and lands from which the river recedes do not change materially, and the map shows by the indentations and heights the probable upper limit of the cut-off of the last century.

The proposition discussed by Assistant Engineer Marshall has already been advanced elsewhere, but it may be repeated here with advantage. "Every tributary to a silt-bearing stream overpoweringly greater in high water entering upon the bar side will be obstructed in the lower stages, but will be open at all stages if entering the bend or channel side." In the course of improving the shallow reaches of Mississippi River large areas have been filled intentionally from a depth of over 20 feet at low water to a height above ordinary high water, often in one flood. Each high water the Mississippi does similar work unaided at the present mouth of Yazoo, which only becomes clear when the great river remains low long enough for the Yazoo to cut its low-water channel. With 8 feet on the gauge I have grounded on this bar with a boat drawing only 30 inches, although the current out was so strong that the usual Vicksburg boats could not enter the river except by the aid of lines and steam capstans. The bottom is not hard but a shifting quicksand, which would not hold either mattress or piling. Four years ago I experimented in a small way in trying to build a jetty at the mouth of Yazoo River, but the piling washed away almost as fast as put in; and the overseer having carelessly let the hammer fall out of the leads, it went down through the sand so fast that it could not be followed with a long pike pole. Steamboat men have told me of similar experiences when they lost freight overboard at the bar.

Capt. Eads made a sketch some years ago for a dike from Delta Point, to force Mississippi River back to the Vicksburg front, which was published in a report on Vicksburg Harbor, and a project was submitted to the Commission to build dikes in the bend above to accomplish the same result, but neither plan was submitted to Congress. Even if dikes or jetties could be built to lead Yazoo River out to deep water they would be objectionable on other grounds than their enormous cost; for as they would have to be built to a high stage they would act like wing dams and throw an excessive volume of water against the opposite bank, endangering the re-

vetment there, and in fact the stability of the whole of Delta Point; and if that should yield the river would cut through and rejoin in the bends below. Again, the further Yazoo River should be extended downstream the less its power would be to keep the bar away from the entrance to the jetties. It seems needless to say more upon this subject, except to add that nearly as much work would be required within the Yazoo from the point where the jetties began to prevent the reappearance of the bar above.

As the mouth can not be improved it becomes necessary to consider the subject of "making a new mouth or outlet by way of Chickasaw Bayou or otherwise." The lines through Chickasaw Bayou and Thompson Lake and through the lakes between the wrong end of Old River and Lake Centennial have been examined with special care, and profiles and frequent sections made, together with discharge measurements of Yazoo River at different stages, and a calculation of the velocities through the several routes. The objections to Chickasaw Bayou or Lake Thompson routes are the shortening of Yazoo River, which would cause injurious changes of slope; the cost of lifting an enormous quantity of earth from the excavation and depositing it at safe distances from the cut; the fact that dredging would not be possible except for a small part of the work, and the great amount of expensive cultivated land that would be needed for the right of way. With these routes it is probable that a high dam would be required to shut off backwater from Mississippi River, and this might exclude many valuable plantations below, which now have free access to Yazoo River.

It is not likely that an engineer could predict with any degree of confidence the probable final section and velocities by these routes, while on the other hand it seems almost certain that the velocities would be so destructive as to tear the canal banks right and left, uutil a tortuous stream had formed with slope and discharge approximating the present regimen of the stream.

But if we take Yazoo at its former mouth on Old River and turn it through the deep water in the wrong end of Old River, thence cut across the lowlands between Long and Barnett lakes to Lake Centennial, Yazoo River may be brought around the head of De Soto Island down Vicksburg Front without dangerous shortening or serious disturbance of slope, and enter Mississippi on the bend or channel side in permanent deep water at Kleinston. This line offers no difficulties either in laying out or prosecuting the work, as the sections may be arranged to permit continuous dredging according to the stage of water, work being done on the land cutting in high, and in the lake or river at lower, stages. The land is much lower than along Chickasaw Bayou, and not much of it is under cultivation, so that a less amount would be needed for the right of way, and the cost per acre be far less. The entire right of way would have to be cleared and about one-third of it grubbed; then a preliminary cut to a certain grade could be made by the most convenient means, so that at a stage of say 30 feet dredges could be worked in the cut, at lower stages on the bank ends and at the lowest in the lake and Old River.

To make the improvement in the shortest time the full amount should be appropriated and the work given out under contract to be pushed night and day. The estimates for this route have been made with this view, and include electric-light plant, telephone lines, various means of transportation for frequent inspections, construction of plant, hire of assistants, inspectors, and laborers to supervise the work and to build mattresses, dikes, etc. The work should be laid out from the first on the basis of 2 meters (say 6½ feet) below the zero of the Kleinston gauge. Mississippi River often falls below zero, and within two or three years has reached a stage of minus 3.90 feet; so that the depth in the cut should always be enough for boats that can navigate Yazoo River in low water. It is also essential to the safety of the canal that the bottom should be below the possible lowest water in Yazoo, which will require a cut not less than 30 meters (say 100 feet) wide, with side slopes not steeper than 1 upon 2; unless it should be thought better to cut full width for equal areas, without regard to side slopes. The greater part of the material must be put in Lake Centennial below the head of De Soto Island, to make a solid filling for the new right bank across the lake, which may be revetted if necessary. The west pass must be closed and filled to ordinary high water.

On the land cut small levees on each side at the limits of the right of way, and again at the edges of the berme banks, must be built for footings for the deposit of about one-third or more of the material to raise the low lands to grade and prevent dissipation of Yazoo into the swamp below, and thence across to the lake and Mississippi River. A levee from the head of Old River will be required to join the levees and embankment on the left bank of the land cut, carried above the highest floods.

Incidentally this work would benefit the whole valley by extending its levee protection downstream.

As Yazoo River fills in the lower section and scours as the rivers fall, it would continue to fill but cease to scour after the new mouth was opened, so that it is very

probable no dam would be needed below the turn at the head of Old River; and with that view the work of building the dam is put last, with the expectation of omitting it altogether.

Attention is invited to the facts shown in Table 4 of Assistant Engineer Marshall's report, in which it will be noted that the mean height of high waters for seven years since the levee system has been restored is the same as the mean for the preceding seven years, while the mean duration of floods appears to be less. Attention is also invited to the hydrograph of high-water slopes from the railway bridge to the Vicksburg gauge, which shows the reduction in the height of high water in Yazoo River with greater gauge readings at Vicksburg since the levees on the Yazoo Front have been completed.

In reviewing recommendations for the work, it must be remembered that the Yazoo Basin comprises a number of rivers that drain a rich country reclaimed from overflow by the work of the Mississippi River Commission, the district levee boards, and the Louisville, New Orleans and Texas Railway Company, and that these rivers, affording a navigation of over 800 miles, are blocked in low water by the bar at the mouth. The people of the valley, as well as the people of Vicksburg, are deeply interested in maintaining the navigation of these rivers as a reasonable check upon the railways that are extending in all directions, while on the other hand those interested in railways should desire increased facilities of navigation to hasten the development and settling of the country, which is large and rich enough to afford good returns to all.

The estimates presented in Assistant Engineer Marshall's report are made with care, but those for the Chickasaw Bayou and Thompson Lake route are too low, in my opinion. But a small amount can be taken out by dredging, and it would be hardly possible to make a preliminary cut into which the dredges could be put at the higher stages, as proposed on the Old River route, so that it would be necessary to estimate as for a deep railroad cutting over the greater part of these lines. What delays might be encountered by floods or from sipe water are matters of speculation, but it is certain the difficulties would be enormous. I should put the excavation by either Chickasaw Bayou or Thompson Lake as not less than 50 cents the cubic meter, and allow a large margin for contingencies, demurrage, etc.

The following table, given in miles for convenience, shows the changes in distance along the several routes, the actual shortening by the proposed route being about 5 miles. As observations for some years have shown that the lake surface varies but slightly from that at Kleinston, being lower on a rising and higher on a falling river, the change in slope by the new route would be taken up in part by raising the lake surface from the mouth of the cut to Kleinston and the rest distributed back to some point above the railway bridge.

Place.	To Kleinston by river.	To Kleinston by new route.
Railway bridge	22.7	
Head of Thompson Lake	18.9	9.6
Head of Chickasaw Bayou	18.6	9.1
Old mouth of Yazoo River	14.2	9.2
Lower end of Old River	16.8	6.5
Present mouth of Yazoo	4.4	
Railway bridge		17.7

ESTIMATES.

1. Cost of right of way, 500 acres, more or less, clearing, grubbing, etc	$75,000
2. Office expenses, resident and division engineers, Chief of Engineers, advertising and printing	13,500
3. Field engineering, surveys, gauges, reports, maps, etc	19,250
4. Inspectors, overseers, etc	40,000
5. Electric light and telephone lines	20,690
6. Plant, levees, mattresses, revetment, dikes and dams	231,560
7. Excavating 4,500,000 cubic metres	1,100,000
Total	1,500,000

Time required three years.

If Congress should approve the project there should be given for immediate examination of the Old River route the sum of $6,000, to be applied to borings on the land-cut, gauges at the mouth of Yazoo River, both in Mississippi River and in the Yazoo, and other gauges at proper intervals from the head of Old River as far up as the Big Sunflower, in order to obtain more accurate information about slopes and discharge, and to make close estimates of the proper section to be given the canal, and the

amount of excavation in the different sections. The borings are especially important to prevent misunderstandings in regard to the nature of the material probably to be met in the land cut.

I am confident, however, that the project is feasible and that the work can be done within the sum I have estimated to give a new outlet to the Yazoo system which shall be navigable at all seasons of the year and make Vicksburg again a river city.

Very respectfully, your obedient servant,

J. H. WILLARD,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. H. M. MARSHALL, ASSISTANT ENGINEER.

VICKSBURG, MISS., *January 28, 1892.*

CAPTAIN: I have the honor to report on the survey of Lower Yazoo River from Anthony's Ferry to the mouth, made in 1890 and 1891.

The act under which the survey was made only passed Congress late in September, 1890, and by the time a party could be got together and the snag boat *Florence* brought from Shreveport to be used for quarters only two days of October remained unexpired. The party consisted of 1 assistant engineer in charge of survey, 1 assistant engineer on triangulation, 1 assistant engineer on precise levels, 1 draftsman, 2 topographers, 1 wye leveler, 1 observer, 1 sounder, 3 recorders, 21 laborers, with boat's crew of pilot, engineer, fireman, steward, 2 cooks, and 2 waiters.

Triangulation was projected from Mississippi River Commission triangulation side "Coast Survey Northeast Base, Delta," to "Fort, Vicksburg," and carried with one side on the hill tops to Chickasaw Bayou and along the bayou to the mouth at Yazoo River, thence one branch of the system was taken up the river to the railway bridge at Anthony's Ferry and one branch down the river to the Mississippi River. The system was not closed on Mississippi River Commission system, as none of their stations in that neighborhood could be found. The results are given in Table 1 herewith.

TABLE 1.—*Tabulated results of tertiary triangulation of Yazoo River survey from Kleinston to Louisville, New Orleans and Texas Railway bridge.*

[Assistant Engineer T. C. Thomas, chief of party; F. Y. Parker, observer; Charles H. Schermerhorn, leveler.]

[NOTE.—Triangulation stations are marked by pieces of vitrified sewer pipe set in the ground and filled with cement; a nail is set for center.]

[NOTE.—Elevations are referred to the Cairo datum, and each elevation applies to the first of the △'s standing opposite.]

Side.	Distance.	Azimuth.	Elevation.
	Meters.	° ′	*Meters.*
Fort—NE. base	2,946.7	75 08	
NE. base—1	2,763.4	223 07	
1—Fort	1,584.8	322 45	34.50
Fort—2	1,316.6	203 07	
2—1	1,477.3	91 58	
2—4	2,192.1	204 17	
4—1	3,073.7	50 41	114.98
1—3	2,237.1	172 18	
3—4	2,691.2	275 45	24.41
6—3	4,587.3	61 55	
6—4	2,788.0	29 26	
4—5	3,070.6	175 04	
6—5	1,755.3	111 23	
5—8	2,291.3	259 31	33.08
6—8	1,224.7	210 20	
6—7	2,166.0	152 15	
7—8	1,840.2	297 52	33.80
8—8*a*	2,373.9	155 34	113.06
7—8*a*	1,452.3	206 22	
7—9	1,925.2	168 10	
8*a*—9	1,191.8	119 18	34.34
8*a*—10	1,025.2	189 17	
9—10	1,278.7	250 25	34.49
9—11	1,044.3	178 22	
Triangulation system divides here; one branch goes up and the other down the river.			
UP RIVER.			
	Meters.	° ′	*Meters.*
10—11	1,379.2	116 29	35.44
10—13	1,338.1	175 39	
11—13	1,341.8	237 36	35.40
10—14	1,289.0	232 03	
13—14	1,242.2	295 50	36.52
14—16	1,219.3	168 24	34.69
16—13	1,090.0	53 12	33.06
13—15	1,577.2	191 00	
15—16	1,062.2	327 26	35.28
16—17	1,909.9	185 08	
17—15	1,251.2	36 25	33.84
15—18	1,137.1	255 00	
18—17	796.4	153 29	33.03
17—19	831.5	264 27	
18—19	922.9	210 45	
18—20	1,382.5	244 38	
20—19	802.8	104 29	32.93
20—21	836.3	198 27	
19—21	1,198.6	240 22	36.43
20—22	1,385.8	231 55	
22—21	828.4	85 45	33.38
21—23	1,438.4	212 29	36.72
23—22	1,153.2	357 20	33.59
22—24	1,077.2	241 45	
24—23	1,190.5	122 38	36.99

TABLE 1.—*Tabulated results of tertiary triangulation of Yazoo River survey, etc.*—**Cont'd.**

Side.	Distance.	Azimuth.	Elevation.	Side.	Distance.	Azimuth.	Elevation.
DOWN RIVER.				DOWN RIVER—cont'd.			
	Meters.	° ′	*Meters.*		*Meters.*	° ′	*Meters.*
10—12	2,219.5	150 27		31—33	1,678.0	78 34	33.61
11—12	1,322.9	186 03		34—33	1,621.7	324 20	
12—26	1,383.4	51 54	35.29	34—35	2,775.8	358 15	
26—11	1,055.5	295 57	35.19	33—35	1,692.1	30 34	
11—25	1,638.7	73 13		36—33	1,963.2	244 12	33.88
26—25	1,122.0	33 32		36—35	1,088.5	303 35	
25—27	1,016.0	119 15	33.28	36—37	2,095.6	357 24	
26—27	1,568.9	73 45		35—37	1,697.8	28 33	34.95
26—28	1,594.7	114 58		38—35	1,704.3	240 55	28.50
28—27	1,113.7	3 07	35.27	38—37	948.1	314 22	
27—29	1,166.7	99 01	33.18	37—39	1,189.3	35 35	34.08
28—29	1,527.9	52 32		38—39	1,630.1	00 30	
28—30	2,205.6	87 05		38—40	2,908.3	33 43	
29—30	1,283.6	129 32	34.13	39—40	1,784.0	63 45	
29—31	2,016.5	67 56		39—41	1,486.8	18 50	
30—31	1,803.4	29 10	27.91	41—40	1,279.3	118 54	34.87
30—32	2,529.3	106 12		40—42	2,415.0	352 22	30.94
32—31	2,757.3	325 48	33.19	42—41	1,946.8	204 14	
32—34	1,661.1	38 46		42—43	2,141.2	293 01	
34—31	2,771.2	290 49	32.90	41—43	2,863.1	335 50	

Precise levels were run from Mississippi River Commission stone ^{101} at Kleinston, which had been previously connected under your direction with Coast and Geodetic Survey bench mark 215 at Delta, La., along the Louisville, New Orleans and Texas Railway to its crossing on Yazoo River 30 kilometers above the mouth. A branch line was also run along the public road from near the National Cemetery to Belle Isle plantation on Yazoo River, about 19 kilometers above the mouth. Results are given in table 2.

TABLE 2.—*Tabulated results of precise level work from Kleinston to the Louisville, New Orleans and Texas Railway Bridge, 1890.*

[Assistant Engineer R. S. Buck, jr., chief of party.]

INSTRUMENTAL CONSTANTS.

Table A.

Kern level.	Pivot correction for distance of 1 meter.	Date of determination.
	Millimeter.	
M. R. C. No. 2	—0.002	Oct. 22, 23, 1890.

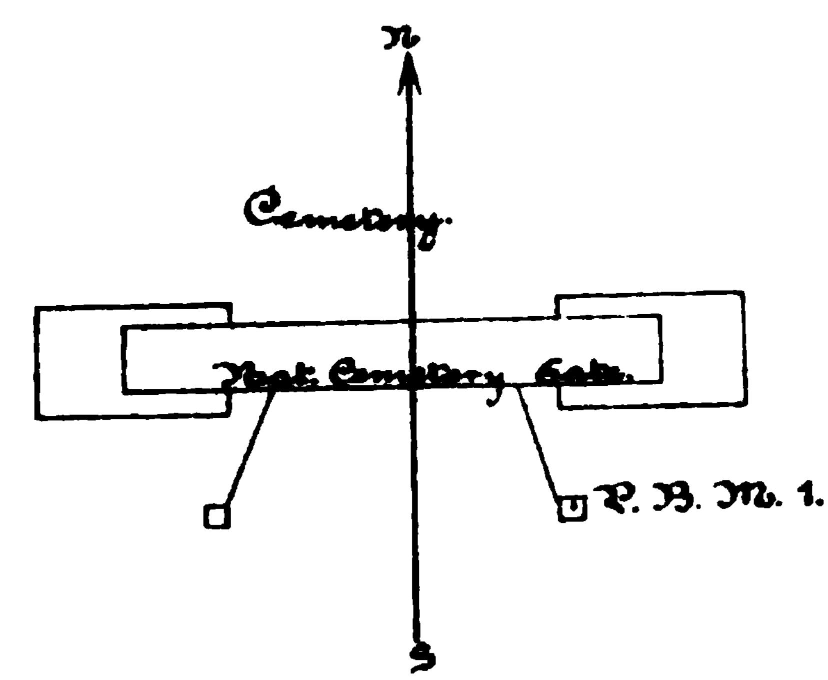
Table B.

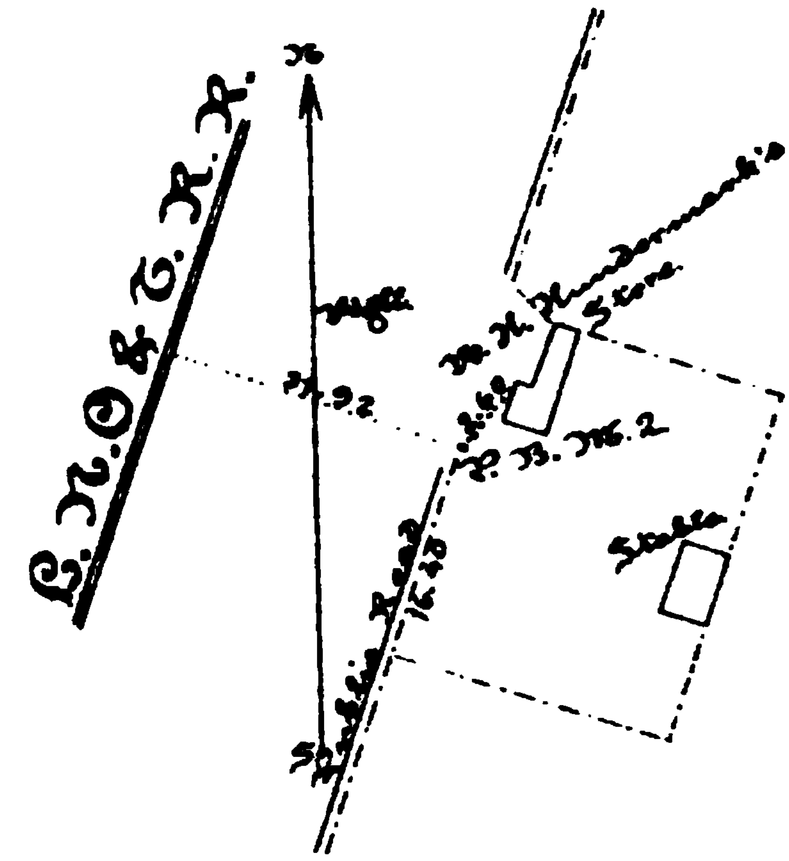
Bubble tube.	Value of one division distance of 1 meter.	Date of determination.
	Millimeter.	
No. 2	0.0153	Oct. 22, 23, 1890.

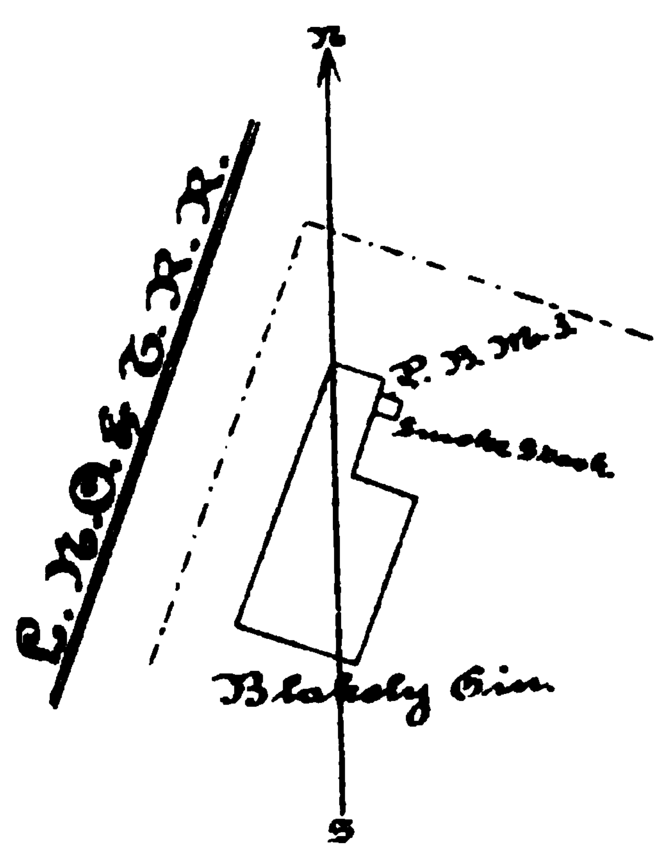
Table C.

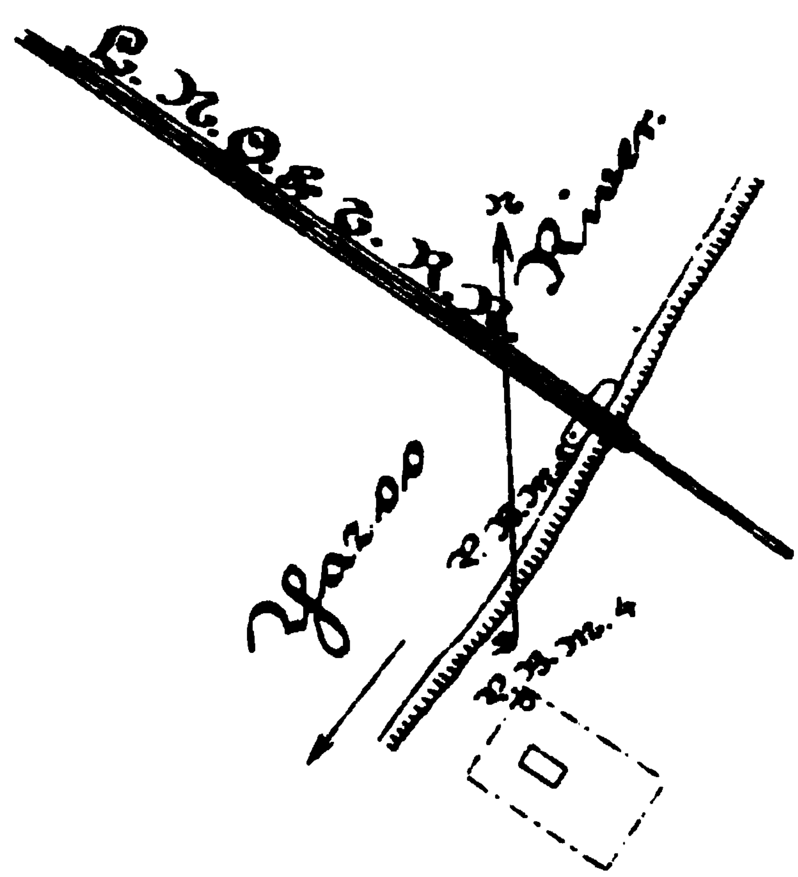
Rod.	Length of 1 meter on rod.	Comparative lengths of spurs.
	Millimeters.	
II	*999.860	Equal.
IV	*999.890	Equal.

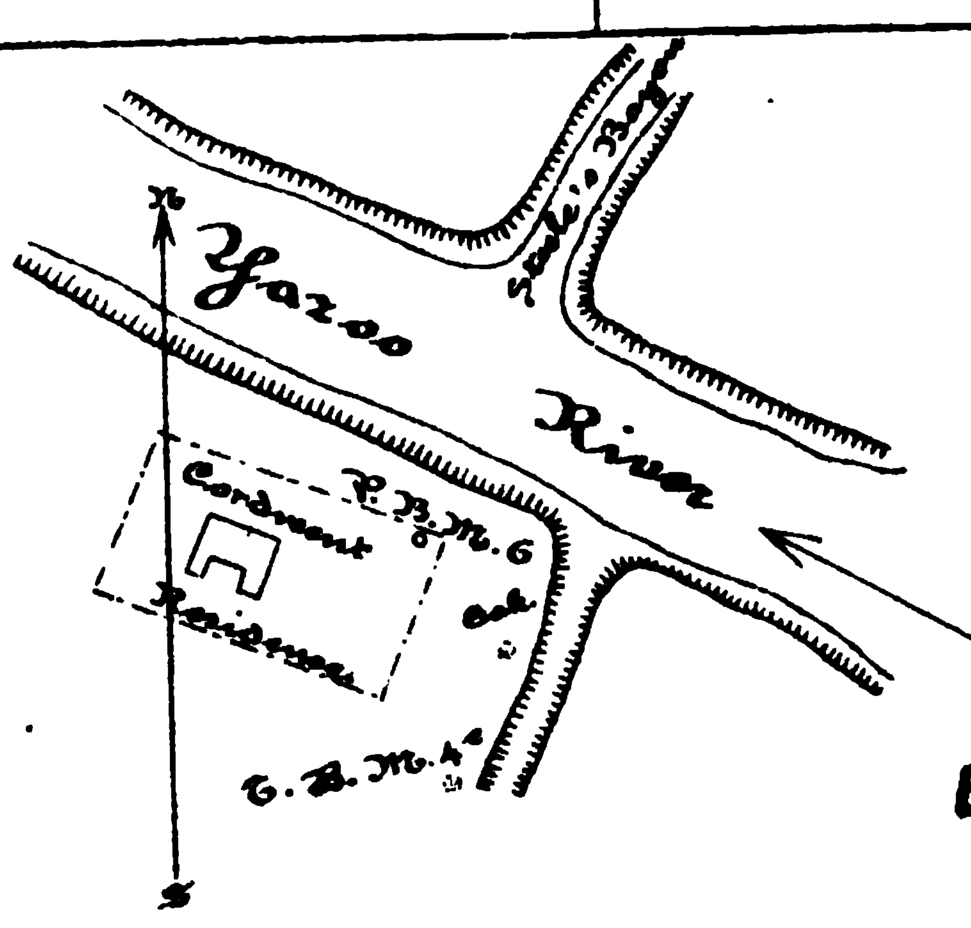
* Mean of Lake Survey and Mississippi River Commission determinations. See M. R. C. Report 1881, p. 51.


N
Cemetery.
P. B. M. 1.
S


L. N. O. & T. R. R.
N
P. B. M. 2
Stable
S


L. N. O. & T. R. R.
N
P. B. M. 3
Smoke Stack
Blakely Gin
S


L. N. O. & T. R. R.
River
Yazoo
N
P. B. M. 4


N
Yazoo
River
P. B. M. 6
Oak
S

ENG 522

Tabulated results.

KLEINSTON TO LOUISVILLE, NEW ORLEANS, AND TEXAS RAILWAY BRIDGE.

[Observer R. S. Buck, jr.]

Bench mark. (M. R. C. Stone line point 1/17. Elevation 33.0132 meters, Cairo datum.)	Distance—		Difference of elevation, not corrected for rod length.		
	Between bench marks.	From Kleinston.	North.	South.	Mean.
	Kilos.	*Kilos.*	*Meters.*	*Meters.*	*Meters.*
T. B. M. 1	1.5	1.5	+2.9887	+2.9924	+2.9905
2	1.8	3.3	+1.3797	+1.3838	+1.3817
3	1.7	5.0	+0.1259	+0.1211	+0.1235
4	1.0	6.0	−0.7572	−0.7546	−0.7559
5	1.8	7.8	−0.8059	−0.8011	−0.8035
6	1.7	9.5	+0.6558	+0.6545	+0.6551
7	1.5	11.0	−0.3788	−0.3830	−0.3809
8	1.9	12.9	+1.1095	+1.1073	+1.1084
9	1.7	14.6	+2.9122	+2.9061	+2.9092
10	1.7	16.3	−3.2550	−3.2489	−3.2519
11	1.8	18.1	+0.6647	+0.6661	+0.6654
12	1.8	19.9	−1.6296	−1.6309	−1.6303

FROM TEMPORARY BENCH MARK 4 TO BELLE ISLE ON YAZOO RIVER.

T. B. M. 4					
4a	1.9	7.9	−3.5232	−3.5187	−3.5209
4b	1.7	9.6	−0.1749	−0.1735	−0.1742
4c	2.0	11.6	+0.5236	+0.5256	+0.5246
4d	1.3	12.9	−0.0852	−0.0864	−0.0858
4e	1.4	14.3	+2.1445	+2.1459	+2.1452

DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS FROM KLEINSTON TO THE LOUISVILLE, NEW ORLEANS AND TEXAS RAILWAY BRIDGE.

[NOTE.—All bench-mark monuments, when not otherwise described, consist of pieces of limestone 46 centimeters square and 15 centimeters thick, marked U. S. O B. M. with spherical-headed copper bolts leaded in upper faces, and buried 1.2 meters underground, access being given through 12-centimeter iron pipes set on top. Each pipe has a cast-iron cover, fastened by a horizontal bolt through cap and pipe. The cap has a small boss and the letters U. S. E. O B. M. raised on top.

Elevations are expressed in meters above the Cairo datum and apply to the top of the bolt in the underground stone. Elevation of boss of pipe can be found in any case by adding 1.24 meters to elevation of copper bolt.]

M. R. C. Stone Line Point 1/17: Stone at Kleinston 110 meters from river bank, 90 meters east of sawmill, 56 meters east of narrow-gauge railroad, 60 meters north of railroad running down to cotton sheds on river bank, and on a line of broken levee extending back to high ground. It is 1,565 meters above oilmill and 1,178 meters below compress. Elevation, 33.0132.

P. B. M. 1: Is cross cut in stone on east side of National Cemetery gate, Vicksburg, Miss., placed to hold the gate when open. Elevation, 37.508.

P. B. M. 2: Is on east side of public road, about 3 kilometers above Vicksburg, by W. H. Hundermark's store, 2.6 meters from northwest corner of yard, 16.4 meters from southwest corner of yard, and 31.92 meters from center of Louisville, New Orleans and Texas Railway track on approximate perpendicular to same. Elevation, 35.580.

P. B. M. 3: Is top of head of large spike driven in north side of brick smokestack of gin on Blakely plantation about 5 centimeters from the ground. Elevation, 39.910.

P. B. M. 4: Is in northeast corner of cabin yard on left bank of Yazoo River about 130 meters southwest of south end of Louisville, New Orleans and Texas Railway bridge, and 20 meters from top of river bank. Elevation, 34.853.

P. B. M. 5: Is cross cut and marked "U. S. B. M." on capstone of south end pier on west side of Louisville, New Orleans and Texas Railway bridge. Elevation, 38.276.

P. B. M. 6: Is on left bank of Yazoo River, almost opposite mouth of Steele Bayou, in northeast corner of E. C. Cordwent's yard, Belle Isle plantation. Elevation, 34.536.

Wye levels were run to connect high-water marks, triangulation stations, water surfaces, and gauges with the precise levels. Stadia lines, with elevations, were run along the banks of all lakes and bayous, and to develop the character of the country between Lake Centennial and Yazoo River as well as along the banks of the river itself. Soundings were taken in the river on cross-sections about 400 meters apart, with soundings in the channel line between. The sections were located by stadia and the soundings by time intervals in crossing. Gauges were set at the head of Lake Centennial, and on Yazoo River at the railway bridge, Chickasaw Bayou, at the old mouth of Yazoo River, and at the present mouth. They were set with zeros at Cairo datum to read the elevation of the water, but on account of the rise in the river above their tops, no record was obtained during progress of the survey. Because of this high stage of the river, when the work reached the mouth shore lines and soundings there were deferred until September, 1891, when a party of topographers and a leveler went to the mouth and supplied the omission, while the United States engineer gauge at Kleinston read 3 meters (about 10 feet). Gauge readings were obtained at the time at the railway bridge and at the mouth of Chickasaw Bayou. All water-surface elevations obtained are given in Table 3.

TABLE 3.—*Water-surface elevations in meters.*

HIGH WATER.

Date.	Vicksburg gauge.	Louisville, New Orleans and Texas Railway.	Hebron's house.	Long Lake.	Mouth of Steele Bayou.	Mouth of Yazoo River.
——, 1867	35.06	36.34	....	35.90	....	....
May 2, 1874	34.06	35.34	....	34.95	....	....
May 8, 1877	32.81	....	....	33.96	....	....
November 20, 1882	34.98	36.56	36.17	....	....	....
November 25, 1884	35.06	36.26	35.87	....	....	....
April 25, 1890	35.06	35.96	35.69	35.41	35.70	35.53
April 24, 1891	34.76	35.91	....	....	....	....

LOW WATER.

Date.	Vicksburg gauge.	Louisville, New Orleans and Texas Railway.	Hebron's house.	Long Lake.	Mouth of Steele Bayou.	Mouth of Yazoo River.
November 17, 1891	19.47	21.93	....	....	....	....
November 27, 1891	20.74	22.70	....	....	....	....
November 28, 1891	20.90	22.83	....	....	....	....

Water surface during survey.

Date.	Vicksburg gauge.	Louisville, New Orleans and Texas Railway.	Mouth of Chickasaw Bayou.	Head of Old River.	Mouth of Yazoo River.
November 10, 1890	25.92	....	26.16	....	....
November 13, 1890	25.74	....	25.99	....	....
November 17, 1890	25.31	25.52	....	....	....
November 19, 1890	25.31	....	25.57	....	....
November 24, 1890	26.56	....	....	26.83	....
November 25, 1890	27.00	....	....	27.24	....
December 4, 1890	27.81	....	....	....	28.09
December 8, 1890	26.65	....	....	....	26.87
December 10, 1890	25.98	....	....	....	26.31

Water surface by gauge readings.

Date.	Vicksburg.	Louisville, New Orleans and Texas bridge.	Mouth of Chickasaw Bayou.	Mouth of Old River.
August 25, 1891	24.05	24.86	24.81	....
August 26, 1891	24.20	24.80	24.79	....
August 27, 1891	24.44	24.87	24.85	....
August 28, 1891	24.82	25.05	25.05	....
August 29, 1891	25.07	25.34	25.38	....
August 30, 1891	25.34	25.57	25.57	....
August 31, 1891	25.44	25.69	25.69	....
September 1, 1891	25.43	25.69	25.69	....
September 2, 1891	25.36	25.60	25.60	....
September 3, 1891	25.25	25.47	25.47	....
September 4, 1891	25.05	25.27	25.28	....
September 5, 1891	24.81	25.05	25.05	....
September 13, 1891	23.77	24.00	....	....
September 14, 1891	23.61	23.85	....	....
September 15, 1891	23.39	23.68	....	23.64
September 16, 1891	23.21	23.52	....	23.46
September 17, 1891	23.00	23.34	....	....
September 18, 1891	22.81	23.18	....	....

Table 4 shows comparative height and duration of high water on Vicksburg gauge for seven years before and after the completion of levees on the Mississippi River.

TABLE 4.

Years.	Extreme high water.	Number of days above 29.27, Cairo datum.	Number of days above 32.32, Cairo datum.
1878	32.62	185	38
1879	32.17	88	0
1880	33.32	154	73
1881	32.86	149	93
1882	34.99	215	183
1883	33.47	162	88
1884	35.06	177	109
Mean	33.49	161.4	82.7
[Levees in Mississippi continuous.]			
1885	33.03	53	24
1886	33.59	100	53
1887	33.75	93	50
1888	33.65	76	26
1889	30.61	57	0
1890	35.06	160	134
1891	34.76	125	87
Mean	33.49	94.8	53.4

As the appropriation was 37½ per cent less than the survey was estimated to cost, no borings could be made. Plate 1* gives the results of borings made in 1871, by Captain, now Lieutenant-Colonel, Chas. R. Suter, Corps of Engineers, on the peninsula, now Desoto Island, opposite Vicksburg. (Report Chief of Engineers, 1872, page 380.) High-water marks were placed and some discharges approximately measured during the high water of 1890. Discharge was measured twice during the progress of the survey by means of the current meter. All results obtainable are given in table 5.

* Plate 1 not printed.

TABLE 5.—*Discharge observations, Yazoo River.*

LOW WATER.

Locality.	Date. Year.	Date. Month.	Date. Day.	Area.	Mean velocity.	Discharge.	Elevation water surface.	Elevation W. S. V. gauge.	Method.	Authority.
				Sq. m.	*Meters.*	*Cu. meters.*	*Meters.*	*Meters.*		
Mouth of Chickasaw Bayou	1890	November.	13	1711	0.139	258	25.99	25.74	Current meter	U. S. E. Survey.
180 meters below Louisville, New Orleans and Texas Rwy. Bridge.	1890	....do	17	1626	0.137	223	25.53	25.31	......do	Do.
Near Louisville, New Orleans and Texas Rwy. Bridge.	1891	....do	27	1262	0.226	285	22.67	20.74	Surface floats	Do.

HIGH WATER.

Locality.	Year.	Month.	Day.	Area.	Mean velocity.	Discharge.	Elevation water surface.	Elevation W. S. V. gauge.	Method.	Authority.
Just below Steele Bayou	1858	February	19	(*)	0.372	1235	(*)	29.97	Surface floats	Humphreys & Abbot.
Do	1858	May	4	(*)	0.611	2613	(*)	34.09	....do	Do.
Do	1858	....do	12	(*)	0.663	2842	(*)	34.18	....do	Do.
Do	1858	June	11	(*)	0.782	3381	(*)	34.33	....do	Do.
Do	1858	July	12	(*)	0.874	3777	(*)	34.36	....do	Do.
Do	1858	....do	24	(*)	0.919	3942	(*)	34.48	....do	Do.
Louisville, New Orleans and Texas Rwy. Bridge (Range 13 N.).	1874	April	10	3098	0.61	1875	34.77	33.47	....do	Maj. Benyaurd.
24 kilometers above the mouth of the Yazoo	1883	March	16	4390	0.396	1736	(*)	33.73	Rod floats	M. R. C. Report, 1885.
Near Chickasaw Bayou	1884	....do	18	3925	1.194	4569	(*)	34.32	Current meter	Do.
Louisville, New Orleans and Texas Rwy. Bridge (Range 13 N.).	1890	May	10	3529	1.061	3743	35.38	34.52	Surface floats	U. S. E. Survey.
Mouth of Chickasaw Bayou (Range O)	1890	....do	9	4106	0.577	2368	35.34	34.57	....do	Do.
Head of Old River (Range 13)	1890	....do	10	4123	0.868	3580	35.12	34.52	....do	Do.
Mouth of Yazoo River (Range 40)	1890	....do	10	4179	0.628	2624	34.96	34.52	....do	Do.

Discharge observations in Chickasaw Bayou at high water.

Locality.	Year.	Month.	Day.	Area.	Mean velocity.	Discharge.	Elevation water surface.	Elevation W. S. V. gauge.	Method.	Authority.
Chickasaw Bayou at the mouth	1890	May	9	488	0.416	203	35.34	34.57	Surface floats	U. S. E. Survey.
Chickasaw Bayou at Hebron's House	1890	....do	9	340	0.445	151	35.12	34.57	....do	Do.
McNutt Lake at Miss Miller's House	1890	....do	9	572	0.181	104	34.86	34.57	....do	Do.

* Not known.

Six map sheets to scale 1-10000, with a title sheet, have been prepared, which show all important features of the country below the railway bridge. One other sheet shows shore lines at the mouth at four periods. Also an index chart showing relative positions of the sheets, and a sheet showing the drainage basin of Yazoo River; the former on a scale of 1-40000, and the latter 1-316800. Four profile sheets with cross-sections have been prepared showing the bottom of the river and both banks, also fragments of the levee from the railway bridge to the mouth of Yazoo River. Two sheets of similar character from the mouth of Chickasaw Bayou to Mississippi River at Kleinston, one sheet through Thompson Lake, and one sheet and a half from the "wrong end of Old River" through Long Lake to the head of Lake Centennial. On the remainder of this sheet is also shown the high-water slopes from all data obtainable, and a comparison of cross-sections on Yazoo River at three places in different years. One profile is on a straight line from the "wrong end of Old River" to Lake Centennial. On this sheet is a graphic representation of the results given in Table 6.

TABLE 6.—*Yazoo River from Louisville, New Orleans and Texas Railway bridge to mouth.*

Locality, in kilometers, from Louisville, New Orleans and Texas Railway bridge.	Sections.	Mean width.		Areas.		Mean elevation of—		Mean elevation.			
								Low water.		High water.	
		High water.	Low water.	Below high water, 1890.	Below low water, 1891.	Channel bottom.	Channel bottom at cross-sections.	Cross-section.	Bed.	Cross-section.	Bed.
		Mrs.	*Mrs.*	*Sq. Mrs.*	*Sq. Mrs.*	*Mrs.*	*Mrs.*	*Mrs.*	*Mrs.*	*Mrs.*	*Mrs.*
0 to 2	13 N, 12 N, 11 N, and 10 N.	290	136	4,044	766	14.7	13.3	16.3	17.7	22.1	23.5
2 4	9 N, 8 N, 7 N, and 6 N....	288	141	4,021	728	14.4	13.9	16.5	17.0	22.0	22.5
4 6	5 N, 4 N, 3 N, and 2 N....	248	134	3,888	724	14.3	13.4	16.2	17.1	21.0	21.9
6 8	1 N, 0, 1, 2, and 3 ....—	260	134	3,771	717	13.1	13.0	16.1	16.2	21.5	21.5
8 10	4, 5, 6. and 7..............	278	145	4,248	969	12.8	11.0	15.5	17.3	20.8	22.6
10 12	8, 9, 10, and 11............	283	141	4,328	917	13.4	11.2	14.7	16.9	20.5	22.7
12 13.9	12, 13, and 14.............	293	167	4,521	1,227	10.5	10.7	13.8	13.6	20.4	20.2
13.9 16	15, 16, 17, 18, and 19.......	1,388	155	12,576	872	17.4	14.4	17.4	20.4	26.6	29.6
16 18.5	20, 21, 22, 23, and 24.......	1,008	174	8,856	731	14.8	14.3	16.5	17.0	26.7	27.2
18.5 21	25, 26, 27, 28, and 29.......	783	201	9,352	200	19.9	19.4	19.8	20.3	23.7	24.2
21 24	30, 31, 32, 33, 34, and 35....	595	265	7,936	220	19.6	19.2	19.8	20.2	22.3	22.7
24 27	36, 37, 38, 39, and 40.......	398	139	4,894	330	17.1	16.2	17.9	18.8	22.7	23.6
27 28	7, 6, 5, and 4.............	271	76	3,494	113	19.0	19.0	19.1	19.1	22.7	22.7
28 29.5	3, 2, 1, and 0..............	257	72	3,409	91	19.3	19.2	19.3	19.4	22.3	22.4

This table is intended to show the relation between high and low water widths, areas, elevation of bottom of the river along the channel, and average elevations of the bed. The area of each plotted cross-section was measured by planimeter, which divided by the width gave the mean depth in the cross-section. This subtracted from the elevation of the water surface that was taken instrumentally gave the mean elevation of the cross-section. The mean of all sections on a reach determined the mean elevation at the cross-sections, and differences between this and the mean of the elevations of the bottom of the channel at the sections gave the amount the bed was on an average above the bottom at those points. This difference added to the average elevation of the bottom of the channel between the sections gave the average elevation of the bed of the river over that reach. This method is adopted because the bottom of a river is in holes and humps, that may exchange places and show differences in cross-sections taken at different periods, when in fact the fill and scour over the reach balance and leave the average elevation of the bed the same.

The foregoing covers all data obtained in the field, and I believe there is nothing more to be desired except the borings and a more extended observation of the water-surface slopes.

Of information on the subject of the Yazoo, the earliest I am able to find is from Claiborne's History of Mississippi. He quotes from the journal of an officer under M. de Noailles, on the expedition in 1739 to the Chickasaw Bluffs to punish the Chickasaw tribe of Indians for massacring the white settlers at Fort St. Peter on the Yazoo River and at Natchez.

"Saturday, the 10th of October, we set out at daybreak and dined half a league from the mouth of the 'Hyazous.' This river appeared to me to run toward the southeast, judging from its mouth. It bears the name of several nations under a common

appellation who formerly resided upon its banks, and are now greatly reduced, owing to continued warfare which we have waged against them, which has caused them to become wandering tribes. This river extends considerably into the interior, and might have brought us to within 10 or 12 leagues from the 'Chicachats,' but being unfortunately difficult of navigation, owing to driftwood, etc., we were compelled to proceed on our course up the Mississippi. At 7 in the evening we encamped one and one-fourth leagues beyond it on the right bank on an extremely slimy shore."

As the "river appeared to run toward the southeast, judging from its mouth," it must have been the old mouth of Yazoo where it enters what is now called Old River, for one exploring the river a mile or so above the mouth would see it bend away to the southeast, whereas had the cut-off then taken place the Yazoo would have appeared to run toward the northeast, judging from its mouth. There is another consideration that leads to the belief that this Old River was then the Mississippi. The early settlers built forts on hills on the river in order to be easily reached by means of their boats, and to be more easily defended in case of attack, hence the Walnut Hills not being touched by the river at that time they ascended the Yazoo and built Fort St. Peter on Snyders Bluff. At some later date the cut-off occurred and the lowland in front of the hills on which Vicksburg now stands was swept away by the river, as was the swamp in front of the hills below the city by the cut-off in 1876. In 1781 when the Spaniards came up the river they found the bluffs jutting out and established Fort Nogales just south of the Mint Spring Branch, which now runs near the wall around the national cemetery. It is safe to say that this cut-off took place between 1739 and 1781. The break through the peninsula was just where the indentation appears on the left bank of Old River about 23.8 kilometers below the present crossing of the railway bridge, and just where the river begins to get narrower. As is usually the case in a cut-off the lower end of Old River filled up, thus forcing Yazoo River to flow up the old bed of the Mississippi. The cut-off enlarged and the Mississippi moved away from the point of the break, cutting away on the west bank and filling on the east, leaving each year a deposit across the mouth of Yazoo through which it cut its bed. This movement must have been uniform and rapid for a distance of 2,500 meters, as is evidenced by the regular growth of timber on the right bank of Yazoo. There must have then been a period of little change, for in 1877 the mouth had moved down only 900 meters from the woods, leaving a bare bar with an abrupt bank at the timber line. From 1877 to 1881 the downward movement was 800 meters, and to 1886 there was a further move of 1,300 meters. From that date to 1891 the movement has been more a shifting of position than progress downward.

During these changes the Yazoo has entered the Mississippi at every angle less than 90° down to its present angle of convergence, and the same hindrance at low stages has obtained at all periods, though perhaps to a somewhat less extent of late years. The angle of convergence, then, is not the controlling element. Neither is the downward movement altogether the factor determining the condition, for there has been quite as much trouble at low water since 1886 as in the years immediately preceding. If then the location of the mouth should be fixed by the use of dikes and revetment, preventing the Mississippi caving its banks and moving to the west, the trouble would still recur whenever there was a sudden fall to very low water at Vicksburg, because of the shifting of the position of the channel of Yazoo River after each high water. Any attempt to fix this channel by means of jetties would certainly serve to direct the flow of the Mississippi against its opposite side and tend to force it away from the Yazoo. It scarcely needs the remark that efforts to prevent bank caving on the Mississippi have proved costly and not always successful, even where there were no dikes to contend with, and what it would cost and how much of success would be achieved is a problem of probabilities in which the possibilities are infinite.

With the Mississippi fixed and the jetties built at the mouth of Yazoo, still the interruption would occur, because the Mississippi, like all silt-bearing streams, builds up the bank on a bar side when its channel is stationary, and would each year fill in between the jetties confining the Yazoo. The only gain then would be that the deposit would have to be scoured away at one fixed position, just as it has now to be at some uncertain place. Possibly the fill between the jetties would not be much if their tops were raised above high water, but they would then act still more powerfully to force the Mississippi away to the west. While this might be beneficial, it could not be successful, except in a limited way.

It seems incontrovertible that every tributary entering a considerably larger silt-bearing stream on the bar side (*i. e.*, slack-water side), will have its mouth periodically closed by sudden fall in the main stream at low water, while on the other hand if it enters on the bend side (*i e.*, channel side), it will not have its mouth closed, or if at all only in exceptional instances. In theory this is substantiated by the fact of the continual building up on the bar side of the main river in one case, and in the other the condition of stability with no fill on the bend side, where what-

ever material is brought by the separate streams is carried away by them combined, or, if the condition is unstable, caving is going on and the mouth of the tributary is continually moved back upstream to deeper water. On account of the lack of record of conditions at the mouths of the tributaries of the Mississippi I am not able to prove the proposition by facts from that stream, and there are no available accurate data on the subject from other rivers. What has been stated concerning the Yazoo may be cited as an example on one side, and all things tend to show that at an early period the mouth of Red River was an instance on the other. When the channel of the Mississippi changed and made a tow-head opposite the point of what is now Turnbull Island, that is made the mouth the slack-water side, navigation became subject to periodic interruptions. This is well borne out by the logical inference of what occurred: First, when the Mississippi cut into Red River the mouth of the latter was necessarily on the channel side of the former. The Mississippi did not continue to move across Red River, for the main bank line of Old River is now not far west of the Red River, hence the mouth continued to be at or near the deep channel; later the tow-head formed and the channel moved away. From the earliest times to a late day the navigation was good and the trouble began in recent years. It is fair to assume that the good navigation was coexistent with the early condition, and the change in navigation accompanied change in the conditions. The first recorded evidence on this point, however, is from the journal of the same officer previously quoted: "On the 19th of September we proceeded at break of day, and at 7 o'clock had reached the entrance of Red River. The mouth of this stream is large and fine and extends towards the north."

The next testimony at hand is from the report in 1860 of Mr. J. K. Duncan, one time Chief State Engineer of Louisiana: "Such had probably been the condition of these rivers for ages, and this was their condition and their several relations at the time they were first discovered by the Europeans, and thence up to the year 1831, when our troubles regarding navigation began to be really serious." A map, Appendix G, Pl. IV, published by the Mississippi River Commission in their report, dated December 21, 1883, shows the bank line in that neighborhood in 1810 and in 1851. From the configuration of the bank the mouth of the river must have been in 1810 very near where the Mississippi channel crosses to the right shore, and as the head of the point had washed off in 1851, as represented by the lines for that year, the current at some time intervening must have swung away, and the Mississippi made the tow-head previously mentioned. The present mouth of Red River is not a fair case by which to try the rule, because though it enters the Mississippi near the head of a caving bend, there are other disorganizing conditions which obscure the relation between cause and effect. It may be observed though that the obstruction to navigation now is not at the mouth, but far up in Old River.

From a map in the Physics and Hydraulics of the Mississippi River it appears that the mouth of White River, where there has never been any serious interruption to navigation, was on the channel side even at that date, while the old mouth of the Arkansas, which was closed at nearly every low water, was on the slack-water side.

There is yet another consideration to be taken into account. From the old mouth of Yazoo River to its present mouth, a distance of 15.5 kilometers, the average elevation of the bottom of the channel is only 0.8 meter below the elevation of extreme low water at Vicksburg, and in this distance there are 8 kilometers in which the channel bottom, at time of survey, averaged from 0.1 to 1.8 meters above that water surface. This reach would all require to be dredged if a deep outlet should be made at the mouth of Yazoo, or else the shallow water would but be moved back up the river. It would either be necessary to move probably 706,600 cubic meters to insure a channel 1 meter deep and 60 meters wide at extreme low water, or the building of jetties to confine the channel all along to cause scour. The amount to be dredged is stated as probable, because the bottom is changeable, and even if the channel should be once completed it would be liable to fill up by slipping in or silting. If jetties were built up to high-water mark the river would certainly excavate its own bed, for wherever confined it has a deep channel, when not hindered by renewed deposit. Opposite the old mouth of Yazoo the bar on the point tailed down the Mississippi before the cut-off, but now the tail turns the other way. The Yazoo turned that bar over, and the current of the river there is strong enough before it loses its energy by dissipation to dig a deep hole in the bottom of Old River.

The channel could be confined by jetties from one or both sides, or a longitudinal jetty the whole way and a levee on the bank nearest the Mississippi.

To sum up the cost of improving the present mouth, the following work should be taken into the account:

Fixing the west bank of the Mississippi River for 1,600 meters above and below the mouth of Yazoo River, 3,200 meters, at $141.90 per meter*	$454, 080
Jetties to exclude waters of the Mississippi and confine the waters of Yazoo, from end of timber line to deep water, 3.2 kilometers on right bank and 2.7 kilometers on left, 1,342,625 cubic meters of willow jetties at 35 cents	469, 919
Same covered with rock 0.25 meter deep, 91,400 cubic meters at $1.50	137, 100
Dike from head of jetty on left side to head of Old River, 12,800 meters at $50	640, 000
Levees from head of jetty on right bank to head of Old River, 1,299,325 cubic meters at 20 cents	259, 865
Add 10 per cent for engineering and contingencies	196, 096
Total	2, 157, 060

To provide a new mouth for Yazoo River through "Chickasaw Bayou or otherwise," some canal would be necessary from the river to Lake Centennial, as that is the only way in which the river could be brought to the Mississippi to enter upon the bend side. If the Yazoo emptied into the Mississippi at Kleinston its mouth would remain unobstructed. The fill in the old bed of the Mississippi from Kleinston back to De Soto Island was due to the channel being over against Delta Point. That side was the concave side of the river, and the channel position there was abnormal, being due to the steep slope caused by the cut-off of 1876. When Delta Point was revetted by the United States and the caving stopped, time was allowed for the river to attain its normal slope. As this came about the centrifugal force tended to make the channel cross to the convex side of the river. As time goes on the channel will move more and more to the Kleinston shore and leave the end of Delta Point. The fill referred to was rapid while the channel moved away, and has been less and less as the river moved back. Local conditions may produce eddies and cause fill, but only over a limited area subject to control.

Table 7 gives the excavation necessary to cut a canal by several routes to planes corresponding to zero and two meters below on the Vicksburg gauge; the canal to be 30 meters wide on the bottom and having side slopes 2 to 1.

TABLE 7.—*Amount of excavation necessary to provide a new mouth for the Yazoo River through Chickasaw Bayou, or otherwise.*

	Grade at head.	Distance in kilometers.	Excavation.	Excavation in Lake Centennial and canal.	Total excavation.	Fall of bottom.
Route by—	*Meters.*		*Cub. mrs.*	*Cub. mrs.*	*Cub. mrs.*	*Meters.*
Chickasaw Bayou	21.00	9.620	3, 739, 145	334, 320	4, 073, 465	1
Thompson Lake	21.00	10.420	4, 287, 317	334, 320	4, 621, 637	1
Old River and Long Lake	21.00	9.015	2, 582, 770	334, 320	2, 917, 090	1
Straight line from Old River	21.00	4.600	2, 561, 760	334, 320	2, 896, 080	1
Chickasaw Bayou	19.00	9.870	5, 492, 295	675, 140	6, 167, 435	1
Thompson Lake	19.00	10.670	5, 707, 845	675, 140	6, 382, 985	1
Old River and Long Lake	19.00	9.070	3, 471, 802	675, 140	4, 090, 090	1
Straight line from Old River	19.00	4.600	3, 408, 705	675, 140	4, 083, 845	1

Table 8 gives high-water elevations and slopes by Chickasaw Bayou route and Old River route. The slope through the former at time of high water would probably produce a mean velocity of 1.553 meters and a discharge of 1,400 cubic meters per second in the canal cut to zero, and 1.635 meters velocity and 1,780 cubic meters discharge in the canal 2 meters below zero. On the Old River route the velocities would be about 1.766 and 1.859 meters, and discharge 1,590 cubic meters and 2,020 cubic meters, respectively, in the canal cut to the two planes.

* Cost calculated from work at Greenville, Miss., Report Chief of Engineers, 1890, page 3248. Cost per mile of completed work $227,040. Brush per cord $1.27½. Stone per ton $1.50.

TABLE 8.—*Elevations and high-water slopes, Yazoo River.*

THROUGH CHICKASAW BAYOU.

Place.	Distance.	High water, 1890.	
		Elevation.	Slope.
	Meters.	*Meters.*	*Meter.*
Louisville, New Orleans and Texas bridge	0	35.96	....
Mouth of Chickasaw	6,500	35.86	0.000015
Hebron's house	2,145	35.69	0.000079
McNutt Lake	3,385	35.43	0.000077
Lake Centennial	2,560	35.06	0.000145
Mouth of Chickasaw to Centennial Lake	8,090	....	0.000099

THROUGH OLD RIVER.

Mouth of Chickasaw	6,500	35.86	....
Head of Old River	13,800	35.68	0.000025
Wrong End	17,300	35.65	0.000009
Long Lake	20,200	35.41	0.000083
Lake Centennial	22,000	35.06	0.000194
Wrong End to Lake Centennial	4,600	....	0.000128

It would be necessary to close "West Pass," the present outlet of Lake Centennial, and place some revetment to prevent the reëscape of water there rather than at Kleinston.

It might become advisable to place a sill across Yazoo River below the head of the canal to force an increased discharge through the cut. The route by Chickasaw Bayou is least advisable, because of the great excess in excavation, and being longer the dredging would be more expensive. The cut itself is longer, and the fall about the same as by Old River; but the shortening from Yazoo River to Kleinston is much greater, hence more likely to produce change in the regimen of Yazoo. More land and of greater value would be taken, with the question of land damages augmented. There is one very favorable feature in this route that possibly should outweigh all against it, to wit: From Yazoo River to the head of Lake Centennial the width of channel would be self-adjusted to accord with the depth, and the depth would be more likely to remain permanent.

Through Old River on the other route, and through Lake Centennial, which is common to both routes, the channel would without doubt be subject to influences nearly identical with those which exist in Yazoo River between its old and its present mouth; and without contraction works to lessen the high-water width, it would do as that river did—fill up. In his work on canal and river engineering David Stevenson remarks that in all river improvements scour is an effect which should be fully taken into consideration by the engineer, especially in forming estimates, and gives a profile to show its importance in the improvement of the river Lune. By dredging the upper shoals in that river the whole lower part was deepened by the natural scour without entailing any expense in its removal. Whether in this case the scour on one part would offset the fill on the other is largely a matter of surmise, because of the absence of exact data, which could only be obtained by numerous borings and detail measurements.

The following items enter in the cost of either route:

Dike across Yazoo River, 497 meters, at $50	$24,850
Mattress across West Pass, 120,000 square meters, at 30 cents	36,000
Dike across Lake Centennial from De Soto Island, 1,000 meters, at $50	50,000
Dredging in Lake Centennial to plane 2 meters below zero, 675,140 cubic meters, at 17 cents	114,774
Add 10 per cent for engineering and contingencies	22,563
	248,187

By Chickasaw Bayou route:

Excavation to plane 2 meters below zero, 5,500,000 cubic meters, at 23 cents	1,265,000
Land, 493.5 hectares, at $200	98,700
Add 10 per cent for engineering and contingencies	136,370
	1,748,257

By Chickasaw Bayou route—Continued.

Should it prove necessary to confine the channel through Lake Centennial, add 4,700 meters of dike, at $50	$235,000
Total	1,983,257

By Old River route:

Work common to both routes	248,187
Excavating to a plane 2 meters below zero, 3,409,000 cubic meters, at 20 cents	681,800
Land, 180 hectares, at $100	18,000
Clearing and grubbing 30 hectares for canal, at $1,000	30,000
Add 10 per cent for engineering and contingencies	72,980
	1,050,967
Should it prove necessary to confine channel in Old River and Lake Centennial, add 8,700 meters dike, at $50	435,000
Total	1,485,967

In conclusion, it should be clearly borne in mind that the estimates are at best only approximations. They are based on such information as could be gathered in a hurried survey, which, however accurate, lacks detail needful to make it worth while to enter into a searching examination by use of applied mathematics. Before so large an expenditure should commence prudence should dictate a thorough investigation to develop as largely as possible the facts and profound study to determine their effect. Works of this character are in a measure necessarily tentative, because numberless physical causes have not yet been assigned any weight in the mathematics of engineers; but that is no excuse for mistakes which are due to want of investigation of the conditions and to utter ignorance of and failure to apply known laws to determine effects that would be plainly discernible by the aid of the light of engineering science.

To the assistants, and especially to Assistant Engineer T. C. Thomas, much credit is due for earnest and intelligent work.

Very respectfully, your obedient servant,

H. M. MARSHALL,
Assistant Engineer.

Capt. J. H. WILLARD,
Corps of Engineers.

Should the bill now before Congress become a law, it is proposed to expend so much of the first appropriation for diverting the Yazoo System as may be necessary in developing the map of the route selected, to determine the boundaries and ownership of the lands that may be required for the right of way, and for the levees that will be needed to prevent overflow by backwater over the left bank of Yazoo River from Chickasaw Bayou parallel to the route through Old River into Lake Centennial; to make borings along the line of the land cutting, and get accurate levels over the right of way and accurate soundings in Old River, Lake Centennial, and the old Mississippi River channel and basin in front of Vicksburg, for the purpose of final estimates.

After the right of way shall have been purchased, or an option obtained for the lands covering it, report will be made with full information to provide for carrying on the work to completion under continuing contracts.

Should the amount in the present bill be appropriated, the estimates given in the foregoing report will be $1,425,000.

For Yazoo River proper, I repeat the recommendations contained in my last report (Report Chief of Engineers, 1891, page 1997), for repairing iron deck and providing new boilers for the snag boat *Meigs*, the

construction of a flatboat with steam hoisting engine and shears, rebuilding the hull of the pumping dredge, and the establishment and maintenance of a system of water gauges.

Detailed estimates for fiscal year 1894.

For diverting the Yazoo System, with provision for completing the work by continuing contracts	$750,000
Repairing snag boat *Meigs*	4,000
Services of snag boat	18,000
For flatboat with steam power	3,000
Services of same	7,000
New hull for dredge	3,000
Services of dredge	2,000
Establishing and maintaining gauges	1,500
Expenses of leveling, monuments, etc	3,500
Office expenses, incidental repairs, tools, outfit, and contingencies	3,000
Total for Yazoo proper	45,000

Money statement.

July 1, 1891, balance unexpended	$13,343.97
June 30, 1892, amount expended during fiscal year	10,263.40
July 1, 1892, balance unexpended	3,080.57
July 1, 1892, outstanding liabilities	7.33
July 1, 1892, balance available	3,073.24
Amount appropriated by act approved July 13, 1892	20,000.00
Amount available for fiscal year ending June 30, 1893	23,073.24

Amounts that can be profitably expended in fiscal year ending June 30, 1894:	
For diverting Yazoo River System	$750,000
For continuing work on Yazoo River proper	45,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

The amounts expended during the fiscal year ending June 30, 1892, and the balances unexpended July 1, 1892, are as follows:

	Expended during year.	Balances unexpended.
For general improvement, care of plant, etc	$9,704.95	$690.35
For pumping dredge-boat	202.99	2,387.99
For survey below Louisville, New Orleans, and Texas Railway Bridge	355.46	2.23
Total	10,263.40	3,080.57

COMMERCIAL STATISTICS.

For a period of sixty days during the past year navigation from Vicksburg was suspended on account of the mouth of the river being closed. With the mouth open the river is navigable its entire length the year round.

List of steamboats that navigated Yazoo River in fiscal year 1892.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Birdie Bailey	Sternwheel	109.74	111.0	22.0	3.5	1 1	4 0	Yazoo City and Belzona.	144	3,309
Blanks Cornwell	do	232.40	140.0	29.0	4.6	2 4	5 2	Vicksburg and Greenwood.	32	702
Lake City	do	35.80	75.0	16.6	4.6	1 4	3 2	Yazoo City and Sunflower River.	105	730
John F. Allen	do	133.90	130.2	24.0	4.2	1 8	4 0	Greenwood and Yazoo City.	10	102
Ike Bonham	do	78.52	93.4	18.0	3.6	1 8	3 6	Vicksburg and Greenwood.	24	201
Addie E. Faison	do	241.50	135.0	30.6	4.9	2 2	5 0	do	35	330
J. B. O'Brien	Tug	44.49	70.8	15.2	7.0	......	......	Natchez and Anthony Ferry.	1	......
Lizzie B.	do	5.00	......	......	......	5 0	5 0	Natchez and mouth of Yazoo.	1	......
Joe Seay	do	27.74	75.0	16.0	6.0	7 0	8 0	Vicksburg and Coldwater River.	1	......
								Vicksburg and Tallahatchee River.	10	100
Hibernia	Sternwheel	157.06	135.0	25.0	4.0	2 0	4 6	Vicksburg and Greenwood.	20	200
								Vicksburg and Yazoo City.	40	......
Dyersburg	do	73.08	93.0	18.4	3.0	1 6	3 0	Not reported	......	......
Gamma	do	44.32	84.0	18.4	4.3	2 6	4 0	Yazoo City and L'Argent.	122	2[illegible]0
General Miles	do	72.45	95.2	17.3	2.1	1 3	3 2	Yazoo City and Belzona.	40	300
Hill City	do	90.00	95.0	22.0	4.5	1 6	4 0	Vicksburg and Sunflower River.	45	58
New Idea	do	146.10	125.0	26.0	4.0	2 0	4 0	Vicksburg and Greenwood.	1	......
Racket	do	52.84	99.0	16.2	3.6	1 10	3 6	do	1	......
Joe	Tug	18.07	44.5	10.0	4.0	5 6	5 9	Vicksburg and various points, towing timber.	18	......
Huston Combs, No. 2.	Sternwheel	95.96	98.0	22.0	3.4	......	......	New Orleans and Tallahatchee River, with four barges.	1	......
H. M. Townsend	do	89.70	116.7	18.0	3.1	......	......	New Orleans and Coldwater River.	1	......

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.
	Tons.	*Tons.*
Cotton	15,653	13,750
Cotton seed	16,570	12,500
Hides and skins	19	10
Live stock	124	60
Lumber	3,318	3,600
Staves	6,864	1,350
Provisions	10,502	9,020
Grain	12,531	11,080
Saw logs	15,000	2,140
Miscellaneous	12,624	10,540
Total freight for Yazoo proper	93,205	64,050
To which should be added the commerce of Tallahatchee River, Tehula Lake, Big Sunflower River, and Steele Bayou, which was brought out through Yazoo River	116,021	97,588
Total Yazoo River and tributaries	209,226	161,638
Estimated value	$7,351,500	$6,315,275

The Georgia Pacific Division of the Richmond and Danville Railroad crosses Yazoo River at Fort Loring, 5 miles below Greenwood, and the Louisville, New Orleans and Texas Railway crosses about 15 miles above the mouth. The latter road has a branch from Clarksdale to Minter City on the Tallahatchee, which will be extended down the stream to Greenwood. The Yazoo branch of the Illinois Central Railroad, from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

V 11.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Tchula Lake or River is the name given to the east and narrowest channel of Yazoo River, where it divides in passing Honey Island. It is wholly within Holmes County, Miss., and is about 60 miles long. Honey Island is about 100 miles above the mouth of Yazoo River, and fertile plantations join each other along its banks, their annual product being estimated at about 20,000 bales of cotton. When the water is high enough to cross the bars the Yazoo and Tallahatchee steamboats make trips through the lake.

In accordance with the requirements of river and harbor act of March 3, 1879, an examination of the lake was made that year with a view to its improvement, and the principal obstructions to navigation were found to be snags and logs in the lower part and leaning timber and shore snags along both banks from the head to the foot of the island. The project contemplated removing these obstructions to permit light-draft boats to enter the lake earlier in the season, and the estimated cost was $10,000, if all the work should be done in one low-water season. (Report Chief of Engineers, 1880, pages 1350, 1351.) The work is of such nature that it must be gone over to remove obstructions that are added from time to time.

The appropriations have been as follows:

By act of—	
March 3, 1881	$3,000
August 2, 1882	2,500
July 5, 1884	1,500
August 5, 1886	2,000
August 11, 1888	3,000
September 19, 1890	3,000
Total	15,000

Operations upon this improvement have been conducted by hired labor. Work was commenced at the head of the lake July 16, 1881, and carried downstream to the foot, where it was suspended September 8, 1881, and consisted of cutting and girdling leaning timber and removing the worst snags. Operations were resumed at the mouth September 1, 1882, and carried up to the head of the lake and suspended the middle of November, 1882. Nothing was done the following season, as no funds were available, but December 22, 1884, work was resumed at the head of the lake and carried down to the foot and suspended February 11, 1885. The next work was done by the United States snag-boat *Meigs*, which was employed December 19–25, 1886, and April 11–30, 1887, in removing the heavier obstructions and clearing a

good navigable channel 90 feet wide for a distance of 44 miles. February 1-19, 1889, the *Meigs* was employed again, and worked from the foot to the head of the lake and back, removing the heavier obstructions, after which operations were suspended until the water should fall sufficiently for a chopping party to commence clearing the banks, but as a favorable opportunity for the advantageous expenditure of the small balance available was not presented during the following season nothing was done until December 10, 1890, when the *Meigs* was used for the succeeding ten days in removing snags, tree slides, etc., from the channel.

The work of chopping parties and the snag boat from 1881 to 1890 resulted in clearing the greater portion of the leaning timber from the banks and in the removal of the main obstructions from the channel, giving greater safety to the passage of steamboats through the lake. The main work then remaining to be done consisted of clearing the new growth of trees and brush from the banks. The brush grew so rapidly and to such extent, that in many places the clear channel scarcely exceeded 50 feet in width, impeding passing vessels and catching drift.

For the removal of these obstructions operations during the fiscal year 1892 were as follows:

After suspending work on bayous Rondoway and Vidal, the chopping party which had been employed on that improvement was transferred to Tchula Lake. The quarter boat and outfit were towed by the United States snag boat *Florence* to the head of the lake, where work was commenced August 18, 1891, and carried down to Dunbarton, about 15 miles above the mouth, where it was suspended December 16, 1891, the available funds being exhausted. During the greater portion of the time the stage of water was very low, and effective work was done. Operations consisted of clearing the brush, cutting shore snags and logs, felling and girdling leaning timber along both banks, and removing snags from the channel as far as practicable. The brush was well cleared, and stumps of felled trees were destroyed wherever there was a probability of their being dangerous to boats. The work was carried on under the supervision of Overseer William V. Hall, who reported the following summary of the four months' operations:

Square yards brush and willows cut	56,735
Logs and shore snags removed	2,743
Leaning trees cut	1,833
Leaning trees topped	79
Trees girdled	1,624
Snags removed from channel	340

The work in this stream has resulted in giving greater ease and safety to the passage of boats, but the period of navigation has not been prolonged; in fact, it is reported that the bars at the head of the lake and below Marcella to the mouth of Black Creek are enlarging gradually, and each year it requires a little higher stage of water to enable boats to pass through the lake. Brush or light pile dams at the bars can be built at little expense, and a considerable increase of depth obtained. The work of clearing the banks, begun last season, should be carried out systematically, and by the expenditure of $6,000 in one low-water season can be completed so that further work would not be necessary for several years.

Money statement.

July 1, 1891, balance unexpended	$3,586.23
June 30, 1892, amount expended during fiscal year	3,556.82
July 1, 1892, balance unexpended	29.41
July 1, 1892, outstanding liabilities	9.00
July 1, 1892, balance available	20.41
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,020.41
Amount that can be profitably expended in fiscal year ending June 30, 1894	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

In general, when the water is high enough, Yazoo River steamboats run through the lake.

List of stern-wheel steamboats that navigated Tchula Lake in the fiscal year 1892.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Round trips.	Passengers.
		Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*		
Addie E. Faison	241.5	135.0	30.6	4.9	2 2	5 0	8	51
Blanks Cornwell	232.4	140.0	29.0	4.6	2 2½	5 2	20	251
John F. Allen	133.9	130.0	24.0	4.2	1 8	4 0	10	62
Gen. Miles	74.25	95.2	17.3	2.1	1 3	3 2	24	50

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.
	Tons.	*Tons.*
Cotton	1,350	1,500
Cotton seed	2,505	2,100
Live stock	24	27
Lumber	1,460	1,230
Staves	....	3,615
Provisions	1,055	500
Grain	1,110	600
Miscellaneous	1,360	700
Total freight	8,864	10,272
Estimated value	$537,000	$492,000

The Yazoo branch of the Illinois Central Railroad from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the lake, and also has a tap line from Tchula to the main line at Durant, and has diverted a large amount of the business formerly done by steamboats.

V 12.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of Tallahatchee River are in Tippah County, in northern Mississippi, whence it flows in a general southwesterly direction through the counties of Union, Lafayette, Panola, joins Coldwater River in Quitman, and then, as the main stream, flows in a southerly direction through Tallahatchee and LeFlore counties, and unites with the Yallabusha in forming Yazoo River.

Under river and harbor act of June 18, 1878, an examination was made that year, and the project based thereon contemplated improvement of low-water navigation of the river from its junction with the Coldwater to the mouth, a distance of about 100 miles, by removal of snags, sunken logs, and leaning timber, and the wreck of the steamer *Star of the West*, 8 miles above the mouth. The estimated cost of the work was $40,000, if completed in two consecutive low-water seasons. (Report Chief of Engineers, 1879, pages 982–986.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$6,000	August 5, 1886	$3,500
June 14, 1880	9,000	August 11, 1888	5,000
March 3, 1881	3,000	September 19, 1890	5,000
August 2, 1882	3,000		
July 5, 1884	3,000	Total	37,500

By the terms of the acts $5,000 of the appropriation of 1880, $2,000 of the appropriation of 1881, and all of the appropriation of 1882 were required to be expended above the mouth of Coldwater to Batesville, in the part of the river known as the Little Tallahatchee, which was not included in the original project or estimate of cost.

The improvement was commenced at the mouth September 18, 1879, by the United States snag boat *Florence*, and carried upstream to within 20 miles of Sharkey Landing, where work was suspended November 20, 1879. Operations during this period consisted of the removal of leaning timber, which obstructed navigation at all stages. The work of the *Florence* was resumed the latter part of August, 1880, at Pecan Point, and continued down to the mouth, where operations were suspended October 18, 1880. For the stretch of river above mouth of Coldwater to Batesville a flatboat was built and fitted up with necessary machinery, and work was commenced early in October, 1880, at the mouth of Coldwater and continued upstream to Batesville, where it was suspended at the close of January, 1881. Operations consisted of removing snags, logs, leaning timber, rafts, and drift piles. This work was resumed at Batesville June 4, 1881, and between that date and August 9, 1881, was carried down to mouth of Coldwater. During this period the river was very low, and in places blocked with drift, through which a channel was cut wide enough for boats to pass on a good stage of water. From the mouth of Coldwater the boat was dropped downstream, removing the principal obstructions, as far as practicable with the limited amount available, on the way, and thoroughly cleaning a bad stretch of river near Pecan Point, complained of by steamboat men, after which work was suspended about the middle of September, 1881. Under the act of 1882 work was resumed at Batesville September 15, 1882, and carried down to within 6 miles of the mouth of Coldwater, where operations were suspended November 30, 1882. Owing to lack of funds nothing was done during the following season, but from No-

vember 1 to December 6, 1884, the United States snag boat *Meigs* was employed in thoroughly clearing the obstructions in the lower part of the river for a distance of about 25 miles above the mouth. Work with the *Meigs* was resumed under the next appropriation December 1, 1886, but December 27 the boat was withdrawn on account of high water until May 11, 1887, after which work was continued until June 10, 1887, and carried from the mouth to Sharkey Landing before the funds were exhausted. No work was done the following year, no funds being available, but May 18–31 and June 13–17, 1889, the *Meigs* again worked over the lower river as high as Williams' woodyard, 18 miles below Sharkey, suspending operations the latter date on account of high water. November 8 to December 24, 1889, the *Meigs* was employed between the mouth and Cassidy Bayou, 1 mile below Sharkey. Under the act of 1890 the *Meigs* entered this river November 1, 1890, and worked rapidly up to Sharkey Landing, as it was desired to carry operations to the mouth of Coldwater before the water should fall. The boat reached a point 6 miles above Sharkey November 7, but found the water too low to go farther, and turned back, and was employed on the 40 miles below Sharkey until November 17. On the latter date a slight rise set in, and the work was carried up to Mead Landing, at mouth of Tillatoba River, about 25 miles above Sharkey, until November 25, 1890. During the remainder of November the boat worked in the lower part of the river. Nothing further was done until June 15, 1891, when the *Meigs*, which had been working in the Yazoo, entered this stream and worked for six days, removing tree slides, etc.

The work from 1879 to the end of the fiscal year 1891 resulted in great benefit to navigation of that part of the river below Sharkey Landing, enabling steamboats to run to the latter place the year round, while before the improvement commenced there was navigation for only about 6 months of the year. While the project contemplated work from the mouth up to the junction of the Coldwater and Little Tallahatchee, little has been done above Sharkey Landing, for the reason that the available funds were not sufficient for extending operations farther, and because the steamboat interest reported that boats would not go above that landing except to make occasional trips into Coldwater River at high stages, when navigation was as good and about as safe as in the lower part of the stream. In 1890, however, the steamboat men requested that snagging operations be extended above Sharkey to the forks.

The work in the Little Tallahatchee River, above the mouth of Coldwater to Batesville, has resulted in no benefit to navigation or commerce, as there has been little or no trade in that part of the stream since the war. It was not recommended by the officer in charge, and at the close of operations in 1882 he reported:

> On the stretch of river between Batesville and the mouth of Coldwater I do not think it advantageous, in a commercial view, to expend any more money. There has not been a boat on this section of the river since the war. I doubt, even if the river was improved, that boats could be induced to run.

During the fiscal year 1892 operations were continued as follows:

The United States snag boat *Meigs*, P. R. Starr, master, commenced work at the mouth October 1, 1891, and continued in this stream until theend of that month, at which time the available funds were exhausted. The river was at a low stage, and effective work was done. A short distance above Pecan Point, about 15 miles below Sharkey, the boat was compelled to turn back October 19 on account of falling river and

the slight depth on bars above. It returned to the mouth and then worked back upstream about 20 miles to Yuba Dam, and at the end of the month returned to Yazoo River. The drag chain was kept down all the time, and where it failed to catch the bottom logs an anchor was dragged to dislodge them. The principal points where work was done are as follows: Dogwood, Dogwood Bend, Emma Cut-off, Glen Burr, Burr Field, Jim White, Terry Field, Parrish, Wildwood, Woodstock, Lock Lomond, New Hope, Shell Mound, Sunny Side, Red Cross, Sandy Ridge Reach, Omega, Holly Grove, Portwood, bends below and above Bayou Winchello, Moss Place, bend below Walton's, Shady Grove, Blythes, and Pecan Point. The master and pilots of the steamer *John F. Allen* (the only boat running in Tallahatchee at the time) reported in commendatory terms regarding this work.

The following is a summary of the month's work:

Snags pulled	291
Stumps pulled	107
Shore snags cut	46
Logs removed from channel	44

Wrecks removed, viz: Large shaft and three flanges of steamer *Edward J. Gay* (burned 1863), near the mouth. Also blew up and removed about 3 cords of frames, deck beams, and sides of steamer *Star of the West* (sunk 1863), 8 miles above the mouth.

There can be no doubt that the work in this river has been of great benefit to navigation from the mouth up to Sharkey Landing, but the trouble has been that with the small amounts appropriated nothing could be attempted beyond the removal of the worst obstructions. Lieut. Col. Benyaurd estimated that the obstructions below the mouth of Coldwater could be removed in two consecutive seasons of low water at a cost of $40,000. The appropriations during a period of thirteen years aggregate $37,500, of which the law required $10,000 to be expended on a part of the stream not included in the original project. New obstructions are brought into the river every year by sliding and caving banks, and the shifting and scouring of the channel exposes others on the bottom or lodges them upon the bars. A snag boat should be used for a short time each year in removing obstructions in the channel, but the appropriation should be large enough to permit the systematic clearing of the banks, and the sum of $10,000 can be expended to advantage in this way in one season of low water, and result in permanent benefit to navigation.

Money statement.

July 1, 1891, balance unexpended	$2,031.02
June 30, 1892, amount expended during fiscal year	2,012.50
July 1, 1892, balance unexpended	18.52
July 1, 1892, outstanding liabilities	17.00
July 1, 1892, balance available	1.52
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,001.52
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

This river was navigable to Sharkey Landing the entire year. During high stages boats ran to Mead Landing, at mouth of Tillatoba Creek, and occasionally into Coldwater River.

List of boats that navigated Tallahatchee River in fiscal year 1892.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	Feet.	Feet.	Ft. in.	Ft. in.			
Addie E. Faison	Stern-wheel steamboat.	241.5	135.0	30.6	4.9	2 2	5 0	Mouth and Sharkey Landing.	14	78
John F. Allen	....do	133.9	130.2	24.0	4.2	1 8	4 0	......do	60	380
Blanks Cornwell	....do	232.4	140.0	29.0	4.6	2 2½	5 2	......do	9	16
Lake City	....do	35.8	75.0	16.6	4.6	1 4	3 2	......do	14	32
Joe Seay *	Tug	27.74	75.0	16.0	6.0	7 0	8 0	Vicksburg and Marks Landing, Coldwater River.	1	....
Huston Combs, No. 2.*	Stern-wheel steamboat.	95.96	98.0	22.0	3.4	......	......	New Orleans and Coldwater River (with 4 barges).	1	....
Six flatboats	Coal flats	......	......	......	......	......	......	Tallahatchee and New Orleans.	1	....
H. M. Townsend*	Stern-wheel steamboat.	89.7	116.7	18.0	3.1	......	......	New Orleans and Coldwater River.	1	....
Racket	....do	52.84	99.0	16.2	3.6	1 10	......	From Vicksburg	1	....
General Miles	....do	72.45	95.2	17.3	2.1	1 3	3 2	Greenwood and Sharkey.	15	30
New Idea *	....do	146.61	125.0	26.0	4.0	2 0	......	From Vicksburg	1	....

* Towboats carrying 1 or more barges.

Summary of commerce reported.

Articles.	1891–'92.	1890–'91.
	Tons.	Tons.
Cotton	5,588	4,000
Cotton seed	8,257	6,000
Hides and skins	53	5
Live stock	31	32
Lumber	1,188	1,424
Staves	3,204	9,245
Provisions	5,571	4,200
Grain	5,725	4,800
Saw logs	24,473	19,000
Miscellaneous	6,329	5,000
Total freights	60,419	53,706
Estimated value	$2,428,000	$2,115,000

The Louisville, New Orleans and Texas Railway has a branch line from Clarksdale to Minter City on the Tallahatchee, which will be extended to connect with the Georgia Pacific near Greenwood, and the Georgia Pacific and Illinois Central Railroads at Greenwood, are competitors for the trade of the Tallahatchee River.

V 13.

IMPROVEMENT OF STEELE AND WASHINGTON BAYOUS, MISSISSIPPI.

Steele Bayou has its source in Swan Lake, in Washington County, Miss.; flows in a general southerly direction, forming the outlet of Lake Washington, with which it is connected by Washington Bayou, a stream

about 7 miles in length, and enters Yazoo River about 12 miles above its mouth. Its course is parallel to the Mississippi and its length about 85 miles; the fall is slight and the stream is not navigable, except when the Mississippi is high enough to fill the lower portion with back water.

An examination of Steele Bayou from its mouth to Swan Lake was made under river and harbor act of August 2, 1882, and in January, 1883, the officer in charge reported adversely to the improvement. (Report Chief of Engineers, 1884, pages 1360–1362.)

The following appropriations have been made, viz:

By act of—	
July 5, 1884	$2,500
August 5, 1886	2,500
August 11, 1888	2,500
September 19, 1890	2,500
Total	10,000

The act of 1884 provided for improving Steele Bayou alone; Washington Bayou has been included in subsequent appropriations. The project contemplates removing snags, stumps, drift, and leaning timber to improve high-water navigation.

Work with a chopping party was commenced at the foot of Swan Lake November 1, 1884, and was carried down to the mouth of the bayou and suspended February 11, 1885, and consisted of the removal of the principal obstructions only. It was resumed November 1, 1886, at the head of Washington Bayou, continued down Steele Bayou about 40 miles, and suspended early in January, 1887, by high water. Nothing was done the following season, as the unexpended balance was not sufficient to resume work. February 11, 1889, a steamboat was hired, and employed for sixteen days in removing obstructions below the mouth of Washington Bayou down to within 8 miles of the mouth, and was then withdrawn on account of high water. July 12–17, 1889, a light-draft steamboat was employed to remove obstructions from Bon Eagle Plantation down to the mouth, about 22 miles. Under the act of 1890, the United States snag boat *Florence* was sent into Steele Bayou February 8, 1891, and worked until the end of that month, when it was withdrawn on account of high water. Operations extended from the mouth up to the foot of Poindexter Island, about 50 miles.

From 1884 to the end of the fiscal year 1891, Steele Bayou was worked over twice from Swan Lake to the mouth, and the obstructions in Washington Bayou were removed in 1886, resulting in greater ease and safety to steamboat navigation at high stages, but operations were by no means thorough on account of the small appropriations.

In the fiscal year 1892 work was continued, as follows:

After suspending operations in Tchula Lake the outfit which had been used in that stream was transported to the mouth of Steele Bayou December 21, 1891, and a chopping party organized. Work was carried from the mouth upstream about 22 miles, and suspended February 12, 1892, when the funds were exhausted. Operations were conducted under the supervision of Overseer William V. Hall, who reported the following summary of work done, viz:

Snags removed from channel	28	Leaning trees topped	100
Jams removed	1	Trees girdled	675
Side jams removed	6	Square yards brush and willows cut	11,800
Shore snags and logs cut	157		
Leaning trees cut	924		

The region bordering the upper part of Steele Bayou and Washington and Swan lakes furnishes the principal products. The lower part of the bayou is subject to overflow from backwater, and not much land in the vicinity is cultivated. The west side of Lake Washington is near the Mississippi, and a loop line of the Louisville, New Orleans and Texas Railway, from Coahoma to Rolling Fork, passes between Swan Lake and Lake Washington, and diverts the main traffic from the bayou before navigation opens. Steamboat navigation in Steele Bayou was not commenced until 1879, and since the construction of the railroad in 1884 it has decreased steadily until for several years past the trade has amounted to little or nothing. In view of the limited commerce to be benefited and the cost of maintaining the work by the removal of new obstructions, added from time to time, it is not believed that any further amount can be expended profitably for the improvement of this stream, and estimates for that purpose are omitted.

Money statement.

July 1, 1891, balance unexpended	$979.34
June 30, 1892, amount expended during fiscal year	966.67
July 1, 1892, balance unexpended	12.67
July 1, 1892, outstanding liabilities	0.31
July 1, 1892, balance available	12.36
Amount appropriated by act approved July 13, 1892	2,500.00
Amount available for fiscal year ending June 30, 1893	2,512.36

COMMERCIAL STATISTICS.

This stream is reported by steamboat men as navigable only when the gauge at Vicksburg reads 33 feet or above.

In the past fiscal year the stern-wheel steamboat *Ike Bonham*, 78.52 tons, made one round trip from Vicksburg to Magnolia, Miss. No other boats ran into the stream.

The commerce reported for the year is given below:

Articles.	1891-'92.	1890-'91.	1889-'90.
	Tons.	*Tons.*	*Tons.*
Cotton	9	1	8
Cotton seed	190	50	346
Lumber (saw logs)	1,335	150	....
Miscellaneous	50	125	....
Total down freights	1,584	326	354
Return freights	100	300	350
Total freights	1,684	626	704
Estimated value	$10,000	$16,000	$50,000

The branch of the Louisville, New Orleans and Texas Railway referred to in this report has diverted traffic from the bayou, and owing to the uncertainty of navigation there is no probability that any portion of the trade will be revived.

V 14.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

Big Sunflower River has its source in Mud Lake, Coahoma County, Miss., 2½ miles from Friars Point, on the Mississippi, flows in a general southerly direction, and enters Yazoo River about 45 miles above its mouth. During extreme high water it is navigable to Clarksdale, about 280 miles above the mouth, but Faisonia, about 144 miles above the mouth, ordinarily is considered the head of navigation.

Under river and harbor act of June 18, 1878, an examination of this river was made, and the project based thereon contemplated the removal of snags, sunken logs, and leaning timber obstructing navigation, and building wing dams to scour a channel from 3 feet to 40 inches deep throughout Oliphant Bar and Muscle Shoals, at an estimated cost of $66,000. Oliphant Bar begins at the mouth of the river and extends upstream 15 miles; Muscle Shoals begin about 38 miles above the mouth and extend upstream about 5 miles. (Report Chief of Engineers, 1879, pp. 982–984.)

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$20,000	August 5, 1886	$5,000
June 14, 1880	8,000	August 11, 1888	5,000
March 3, 1881	4,000	September 19, 1890	5,000
August 2, 1882	5,000		
July 5, 1884	5,000	Total	57,000

The improvement was commenced in the fall of 1879. A light-draft steamboat was chartered September 11 and employed until November 27, 1879, in removing snags, logs, etc., and building 10 wing dams at Oliphant Bar, which increased the depth of water to 3 feet where there had been but 18 inches, and 3 wing dams at Muscle Shoals. These dams were inexpensive structures of light piles and brush, but answered the purpose for which intended. Work was resumed June 19, 1880, with a light-draft steamboat, hired for the purpose, and continued until December 4, 1880, when it was suspended by high water. During this period operations were carried from the mouth up to Faisonia, and consisted of removing snags and logs from the channel, leaning timber along the banks, and building wing dams at Callao and Vick Landing, which increased the depth of channel from 18 inches to 3½ feet. The next season a chopping party commenced the removal of leaning timber and snags at Clarksdale June 10, 1881. This work was carried downstream until June 24, when the party was moved down to Faisonia, where operations had ceased in 1880. From June 29 to September 15, 1881, work was carried from Faisonia upstream to Dougherty Ferry, after which the force was transferred to the lower part of the river, where it was employed in removing obstructions, repairing the dams at Callao and Vick Landing, and building new dams at Shell Ridge until October 27, 1881, when work was suspended by high water. In 1882 operations of a chopping party commenced August 26, and were continued until the latter part of January, 1883. Work during this period extended from Standing Stump upstream to Clarksdale, and included all the upper river that had not been worked over previously. Nothing was done the following season, as no appropriation was made and the balance available was not sufficient to resume operations. Under the act of 1884 a light-draft steamboat was chartered October 12 and employed in the lower river until December 21, 1884, in removing snags,

logs, etc., and building and repairing wing dams where needed. This work was supplemented by operations of the United States snag-boat *Meigs* January 1–18, 1885. From June 14 until August 26, 1887, operations were continued below Faisonia by means of a light-draft steamer, hired for the purpose, and a force of 25 to 30 men. This work consisted of removing obstructions from the channel and building wing dams where needed at the shoals. June 7, July 7, and September 1–9, 1889, a steamboat was employed in going over the work below Faisonia, removing obstructions and building and repairing dams. January 10 to February 13, 1891, the United States snag-boat *Meigs* was employed in the river below Faisonia, but was withdrawn the latter date on account of high water. In addition to the removal of obstructions, brush dams were built by the *Meigs* at head of Muscle Shoals and at Hollywood Bar. The water remained too high to resume work until the latter part of May, but June 1, 1891, the snag-boat *Florence* was sent into this river and worked until the end of the month removing obstructions between the mouth and a point 18 miles above Faisonia.

Operations from 1879 to the close of the fiscal year 1891 extended over the navigable part of the river from Clarksdale to the mouth, though little has been done above Faisonia since 1882, for the reason that it would have resulted in no benefit to commerce or navigation to clear the upper river and allow the lower part to remain obstructed, the appropriations being too small to permit work over the whole. To obtain the greatest benefit with the means available, it has been the endeavor, therefore, to keep the lower river open to navigation the year round, with the view to extending navigation to Lehrton, or higher, as the work progresses. Regarding the benefits derived from the work done, the steamboat men report as follows: Before the improvement commenced the river was navigable for very light boats about 6 months of the year; now it is navigable the year round, but difficult and dangerous at low stages on account of shoals, snags, and sunken logs. Larger boats are used, and make the round trip (about 180 miles and return) in 5 days, while before the improvement it was unusual for a boat to make the trip under eight days. Freight rates are reported to be 50 per cent less. The lands along the river are being cleared and settled rapidly of late years, which is attributed in part to the improved navigation.

In the fiscal year 1892 operations were continued as follows:

As the balance available July 1, 1891, was but $799.14, little work could be accomplished, and it was decided that nothing would be done until one of the snag boats should be available at a favorable stage of water. This opportunity presented itself when the snag boat *Florence*, J. H. Lewis, master, was on the way back from Tchula Lake, after towing the quarter boat and transporting the chopping party to that stream. The *Florence* entered Big Sunflower River August 18 and continued work until August 30, 1891, when the funds were exhausted and the boat returned to Vicksburg. Operations were carried up to within one-half mile of Faisonia, and the following obstructions removed:

Stumps pulled	18
Logs removed from channel	33
Leaning trees cut	23

Cut off sharp point which had 129 trees and saplings on it.

The water was at a low stage, and all the stumps and logs were taken directly from the channel.

The following extract from my annual report for 1891 remains applicable to this work:

It is recommended that future appropriations shall not restrict expenditures to designated stretches of river, in order that the funds may be applied where the work is needed most and where it will yield the greatest benefit to navigation.

The estimate of $66,000, made in 1879, for the improvement of this river (page 984, Report Chief of Engineers, 1879), did not contemplate doing the work at irregular intervals extending over a period of fifteen years, as it will with the usual appropriations, but was made with a view to finishing it in not more than three or four consecutive seasons. As new obstructions are added from time to time, it is impossible to make any definite estimate, but if an appropriation of not less than $20,000 is made it can be spent to advantage and with economy in one or two low-water seasons, and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

Money statement.

July 1, 1891, balance unexpended	$803.93
June 30, 1892, amount expended during fiscal year	739.04
July 1, 1892, balance unexpended	64.89
July 1, 1892, outstanding liabilities	.29
July 1, 1892, balance available	64.60
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,064.60
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20,000.00

COMMERCIAL STATISTICS.

In the past fiscal year this river was navigable the whole period, from the mouth to Woodburn (80 miles). During medium and high stages boats ran in the upper river to Faisonia (144 miles) and above.

List of stern-wheel steamboats that navigated Big Sunflower River in fiscal year 1892.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.		Draft. Loaded.		Between—	Round trips.	Passengers.
		Feet.	Feet.	Feet.	Ft.	in.	Ft	in.			
Birdie Bailey	109.74	111.0	22.0	3.5	1	10	4	0	Holly Bluff and mouth	17	32
Lake City	35.80	75.0	16.6	4.6	1	4	3	2	do	38	130
Ike Bonham	78.52	93.4	18.0	3.6	1	8	3	6	Woodburn and mouth	7	20
Addie E. Faison	241.50	135.0	30.6	4.9	2	2	5	0	Solo and mouth	6	110
Hibernia	157.06	135.0	25.0	4.0	2	0	4	6	Vicksburg and Osceola	1	210
									Vicksburg and Campbellsville	20	
Dyersburg	73.08	93.0	18.4	3.0	1	8	3	6	Vicksburg and Cobb Place	10	146
Gamma	44.32	84.0	18.4	4.3	2	6	3	10	Yazoo City and Campbellsville	75	163
Uncle Billy	79.81	88.1	7.7	3.9	1	4	3	0	East Renovo and mouth of Hushpuckena River.	30	75
Hill City	90.00	95.0	22.0	4.5	1	6	4	0	Vicksburg and Lehrton	27	470
									Vicksburg and Shell Ridge	20	
General Miles	72.40	95.2	17.3	2.1	1	3	3	2	Vicksburg and Woodburn	6	20

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.	1889-'90.	1888-'89.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Cotton	4,118	2,375	2,594	4,000
Cotton seed	5,450	3,500	3,975	6,000
Hides	12			1
Live stock	265	70	150	150
Saw logs	21,835	15,400	4,000	
Lumber	906	920	869	
Staves	4,430	3,219	5,250	490
Miscellaneous	2,549	2,027		3,880
Total down freights	39,565	27,511	16,838	14,521
Return freights	7,489	4,473	5,322	9,680
Total freights	47,054	31,984	22,160	24,201
Estimated value	$1,354,000	$945,000	$1,240,000	$1,858,000

The Louisville, New Orleans and Texas Railway crosses the river at Clarksdale, and thence south runs parallel to the stream, at distances varying from 5 to 20 miles. The Georgia Pacific Division of the Richmond and Danville crosses the river near Johnsonville with a line running from Arkansas City on the Mississippi River to Atlanta, Ga.

V 15.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

Big Hatchee River has its source in northern Mississippi, flows in northwesterly and then westerly direction through the most productive region of West Tennessee, and enters the Mississippi River 50 miles above Memphis. It appears that navigation of this stream was commenced as early as 1827; that in 1841 and 1842 the State of Tennessee appropriated $100,000 for improvement of rivers in the western part of the State, one-third of which was expended on Big Hatchee, after which the amount of commerce was considerable, six or seven steamboats having been employed during the cotton season, and there was navigation for light-draft boats the year round. In 1866 the legislature of Tennessee declared the stream unnavigable, and authorized the construction of fixed railway bridges across it, in consequence of which navigation was suspended until 1879, when the act was repealed, and the railroad companies changed their bridges to conform to the law.

Under section 2 of river and harbor act of August 14, 1876, which provided for "examination and survey of such rivers and harbors as, in the judgment of the Secretary of War, will subserve the general interests of commerce," an examination of this river was ordered, but, in view of the State law declaring the river unnavigable, it was deferred until 1879, after the repeal of the act by the legislature of Tennessee. The project, based upon this examination, contemplated the removal of snags, logs, leaning timber, etc., to render the stream navigable throughout the year for light-draft boats from Bolivar, Hardeman County, Tenn., to the mouth, a distance estimated to be about 240 miles. The plan of operations contemplated completing the work in three consecutive seasons of low water at a cost of $30,000. (Report Chief of Engineers, 1880, pages 1330–1332.)

The appropriations have been as follows:

By act of—		By act of—	
June 14, 1880	$10,000	August 11, 1888	$5,000
March 3, 1881	3,500	September 19, 1890	5,000
August 2, 1882	3,000		
July 5, 1884	2,500	Total	32,000
August 5, 1886	3,000		

Operations from the commencement of the improvement by the United States to the close of the fiscal year 1891, were as follows:

A chopping party commenced work at Bolivar August 13, 1880, and continued downstream to the mouth of the river, which was reached December 10, 1880. This work consisted chiefly of clearing the leaning timber, but snags and logs were removed from the channel wherever practicable with the means at hand. In 1881 work with a chopping party was resumed at Bolivar June 22, and between that date and October 15 was carried down to the mouth, special attention being given to the removal of obstructions in the channel. August 28–November 4, 1882, the work was gone over again, from Bolivar down to Reed Landing, 27½ miles above the mouth, many new obstructions having been added during the year, by caving banks, etc. Owing to lack of funds, nothing further was done until December 14, 1884, when a chopping party commenced work at Piljerk Landing, 40 miles above the mouth, and continued upstream about 40 miles, thoroughly removing all obstructions to navigation, until February 10, 1885, when operations were suspended by high water. Nothing could be done the following low-water season, as the balance available was insufficient to resume operations. October 15, 1886, work was begun at the mouth and continued until January 15, 1887, when it was stopped by high water, having been carried up to Rialto, about 60 miles. The small balance left was expended June 17–27, 1887, in working from Rialto back to the mouth, giving a fair navigable channel in that stretch of river. The next work, April 5–June 14, 1889, was carried from Rialto upstream to the Louisville and Nashville Railroad Bridge, a distance of about 60 miles, and August 19–October 31, 1889, a hand-propelled snag boat was employed in removing obstructions from the bottom of the river below Rialto, clearing a good channel between that place and the mouth with a depth of 2½ feet at low stages. The appropriation of 1890 was made late in the season, and as the river was at a stage too high for advantageous work during the greater portion of the time to the end of the fiscal year 1891, work was not resumed.

Before the improvement was commenced the river virtually was unnavigable by reason of the obstructions; in 1889 it was reported navigable for seven months, and during the fiscal year 1891 it was reported navigable for nine months. Between Bolivar and its mouth the stream is crossed by four railroads, about 60 miles apart, which transport the principal products of the adjacent country, and the main effect of the work done has been to facilitate the transportation of timber and staves and prevent excessive rates of freight. The fixed bridge of the Tennessee Midland Railway, about 60 miles below Bolivar, prevents navigation by steamers above that point. If this bridge is provided with a draw, and the snags and leaning timber removed so as to permit light-draft boats to run the year round, there is a probability that the steamboat trade may be revived, though not to the extent of the period prior to the war, before the railroads were built.

Operations during the fiscal year 1892 were as follows:

Owing to the difficulty of hiring a boat of sufficient strength and

with appliances adapted to removing obstructions, without great cost, it was deemed advisable to defer work until the United States snag boat *Florence* completed operations in Forked Deer River. The *Florence*, J. H. Lewis, master, commenced work at the mouth of Big Hatchee January 1, 1892, and continued up to Green Landing, a distance of about 67 miles, where it was suspended March 5, 1892, by high water. The following is a summary of the work done during this period:

Stumps pulled	46	Leaning trees cut	6,677
Shore snags cut	496	Leaning trees topped	21
Logs removed from channel	105	Trees girdled	6,518
Side jams removed	14		

Continued high water to the end of the fiscal year prevented further operations.

The small amount of commerce to be benefited is not at all commensurate to the cost of continuing this improvement, or to maintaining what has been done, and for this reason it is not believed that any further amount can be expended profitably unless a greatly increased business should be developed.

Money statement.

July 1, 1891, balance unexpended	$5,000.81
June 30, 1892, amount expended during fiscal year	2,822.33
July 1, 1892, balance unexpended	2,178.48
July 1, 1892, outstanding liabilities	2.56
July 1, 1892, balance available	2,175.92
Amount appropriated by act approved July 13, 1892	3,500.00
Amount available for fiscal year ending June 30, 1893	5,675.92

COMMERCIAL STATISTICS.

On May 20, eleven printed requests for commercial statistics were sent to steamboat masters and all other persons understood to be engaged or interested in navigation of this stream. But three replies were received, two of which reported no business done. From the third, the commerce for the year appears to have been as given below. No information of any steamboat being in the river during the year was received.

Summary of commerce reported.

Articles.	1891–'92.	1890–'91.
	Tons.	*Tons.*
Cotton		23
Lumber (saw logs)	4,450	6,010
Staves and heading	500	11,600
Miscellaneous		25
Total freights	4,950	17,658
Estimated value	$30,000	$184,500

The Illinois Central Railroad crosses the river at Bolivar, the head of proposed improvement; the Tennessee Midland Railway crosses at Hatchee Station, about 178 miles above the mouth; the Louisville and Nashville Railroad crosses at Big Hatchee Station, about 117 miles above the mouth; and the Newport News and Mississippi Valley Railroad crosses at Rialto, about 57 miles above the mouth.

V 16.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

Main Forked Deer River, 24 miles long, is formed by the junction of the North and South Forks in Dyer County, West Tennessee, about 9 miles below the town of Dyersburg, flows in a southwesterly direction, enters Obion River 4 miles above its mouth, and thus finds an outlet to the Mississippi at Hale Point, 95 miles above Memphis. Originally the mouth of Forked Deer River was near Ashport, 18 miles below Hale Point, but about fifty-three years ago the State of Tennessee cut a canal to a bend of the Mississippi (now the mouth of Obion River), shortening the length of main Forked Deer River about one-half. The original outlet below the canal is closed with snags and drift, and is called "Old" and "Lost" channels. The canal is known as "Tigertail." North Fork is formed by several small creeks near Trenton, in Gibson County, flows in a westerly direction to Dyersburg, thence southwesterly. South Fork heads in McNairy and Henderson counties, and flows in a general northwesterly direction. Appropriations aggregating $43,000 were made by the State of Tennessee for the improvement of Forked Deer River, at various times within the twenty years preceeding 1874, but their expenditure resulted in little or no benefit to navigation.

Under river and harbor act of March 3, 1873, an examination was made from Dyersburg on the North Fork to mouth of main river, the report on which recommended that, in view of the cost of the work in comparison with the small amount of commerce to be benefited, the improvement should not be undertaken by the United States. (Report Chief of Engineers, 1874, Part I, pages 372–380.) Under act of June 14, 1880, an examination of the South Fork and reëxamination of the North Fork and main river were made (Report Chief of Engineers, 1881, pages 1489–1497), and under act of August 5, 1886, a third examination of North Fork below Dyersburg and the main river was made (Report Chief of Engineers, 1887, pages 1494–1495).

The original project contemplated the removal of snags, logs, leaning timber, etc., to give greater ease and safety to navigation of South Fork between Brownsville Landing and its junction with North Fork, a distance estimated to be about 73 miles, which was modified in 1883 so as to extend operations up to Jackson, Tenn., the head of navigation, about 74 miles above Brownsville Landing. By the act of 1888 the improvement of North Fork and main river were added under the general title Improving Forked Deer River, and the project contemplated the same class of work in the 9 miles of North Fork below Dyersburg and thence down the main stream to the mouth. The original estimates of cost were $19,250 for South Fork, $4,500 for North Fork, and $7,000 for the main river, but as they were based on plans for completing the work in one season, the cost will be increased, as new obstructions are added from time to time.

The appropriations have been as follows:

By act of—	
August 2, 1882, for South Fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888:	
For South Fork	2,500
For North Fork	4,500
For main river	2,500
September 19, 1890, for North Fork and main river	2,500
Total	22,000

Operations from the beginning of the improvement by the United States to the close of the fiscal year 1891 were as follows:

Work, with a chopping party, commenced at the mouth of South Fork July 7, 1883, and continued until November 16, 1883. During this period the water was at a low stage, and the removal of leaning timber, logs, snags, etc., was carried upstream to Jackson. Under the act of 1884 work was resumed October 1, 1884, at Jackson and carried downstream about 54 miles to Bell Depot, where operations where suspended December 17, 1884, the available funds being exhausted. Nothing further was done until October 27, 1886, when operations were begun at the mouth, and between that date and June 16, 1887, were carried upstream to within 4 miles of Bell Depot. No work was done the following season, no funds being available. The next and last work done in South Fork commenced early in December, 1888, near the brush dam below Bell Depot, where operations were suspended in 1887. By means of explosives a channel 100 feet wide was cleared through the dam, after which the removal of snags, logs, leaning timber, etc., was carried up to Jackson and then back to the mouth, reaching the latter point March 9, 1889. April 1–17, 1889, the small balance available was expended by a small hand-propelled snag boat in removing leaning timber and heavy channel obstructions which had collected in the 8 miles above the mouth.

Work in the North Fork below Dyersburg was commenced by a chopping party October 3, 1888, at the mouth, and the principal shore work was completed November 27, 1888. Channel work with a hand-propelled snag boat, fitted with light shears and steam power, commenced December 6, 1888, and continued, when the stages of water would permit, until May 31, 1889, resulting in a good channel with a least depth of 2½ feet at ordinary low stages of water. November 1–23, 1889, the work was gone over, and, and it was found that the channel had scoured considerably and was well defined, with caving banks at but few places. Wherever there were evidences of caving the banks were cleared for some distance back, and the snags and stumps that had scoured loose were removed.

Work in the main river was begun with the hand-propelled snag boat November 10, 1888, but after twelve day'swork was suspended by high water, which prevented resuming operations until June 10, 1889. From that date until the end of July, 1889, with the exception of a week's suspension by a sudden rise, the snag boat and a chopping party were employed in removing the obstructions as thoroughly as practicable with the limited amount available for the purpose. At extreme low water the following October a number of stumps obstructing the channel below White Oak Landing were removed, after which work in the main river was stopped.

The amounts expended to June 30, 1891, were, for South Fork, $12,500,

for North Fork, $4,500, and for the main river, $2,500. With these expenditures the two forks were put in fairly good navigable condition, but no material improvement was gained in the main stream. Navigation of South Fork is carried on by flatboats, loaded with staves and lumber, and rafts of saw logs. Before the improvement commenced about one boat in three was lost, on account of the obstructions; now they make the trip in comparative safety and at less cost. The work in North Fork below Dyersburg enabled boats to run at a stage 3 feet lower than formerly.

In the fiscal year 1892 the funds available were "expended on the North Fork from Dyersburg to the main river, and thence on the main river to its mouth," as required by the act of 1890, and operations were as follows:

The United States snag boat *Florence*, J. H. Lewis, master, was fitted out for work in Forked Deer River in September, 1891, but on the eve of departure request was made for temporary use of the boat for urgent work in Lieut. Millis's district, at mouth of Red River, which was granted. The *Florence* returned to Vicksburg October 19, and communication was opened at once with steamboat men at Dyersburg, to ascertain if the boat could enter the mouth of Forked Deer at the low stage of water, and upon the receipt of affirmative information it left Vicksburg October 24, stopped at Memphis October 31 to receive fuel, cordage, supplies, and a pilot, and entered Forked Deer River, and commenced work November 2. Operations continued until the funds were exhausted, December 30. During the entire period the water was at a low stage, and effective work was done in the way of removing logs and stumps from the channel, extending over the entire stretch of river provided for by the appropriation, from the mouth up to Dyersburg and back. The following is a summary of the work reported:

Stumps pulled	81	Leaning trees cut	1,119
Shore snags cut	421	Leaning trees topped	26
Logs removed from channel	159	Trees girdled	150
Jams removed	6		

Removed old sawmill track from channel.

This work resulted in a greater depth of clear channel between Dyersburg and the mouth by the removal of snags and logs, and gave greater ease and safety to the passage of boats.

In view of the limited amount of commerce to be benefited, no estimate is made for continuing work in the fiscal year ending June 30, 1894.

Money statement.

July 1, 1891, balance unexpended	$2,500.00
June 30, 1892, amount expended during fiscal year	2,496.25
July 1, 1892, balance unexpended	3.75
July 1, 1892, outstanding liabilities	1.20
July 1, 1892, balance available	2.55
Amount appropriated by act approved July 13, 1892	3,000.00
Amount available for fiscal year ending June 30, 1893	3,002.55

COMMERCIAL STATISTICS.

North Fork and the main river were reported navigable to Dyersburg from November 1 to June 30 in the past fiscal year. No commerce was reported from South Fork.

List of steamboats engaged in navigation during fiscal year 1892.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. in.*	*Ft. in.*			
Peoria Belle*	Tug	31.07	70.3	12.6	4.4	4 6	6 6	Dyersburg and Hales Point on Mississippi River, and points on Obion and Forked Deer River.	....	650
James Laughlin	Tug	28.76	71.5	15.0	4.5	5 0	5 6	Stevens Mill on Obion River, and Dyersburg on North Fork.	38	98

* The number of trips made by the *Peoria Belle* was not reported. Both tugs carried barges for freight and passengers.

Summary of commerce reported.

Articles.	1891-'92.	1890-'91.
	Tons.	*Tons.*
Cotton	98½	6
Cottonseed	100	25
Hides and skins	2½	....
Live stock	18	....
Lumber (principally saw logs)	12,000	9,200
Staves	3,580	24,000
Miscellaneous	44	....
Total freights	15,843	33,231
Estimated value	$108,000	$250,000

South Fork is crossed at Jackson by the Illinos Central Railroad, the Mobile and Ohio Railroad, and the Tennessee Midland Railway; and at Bell Depot by the Louisville and Nashville Railroad; and the Newport News and Mississippi Valley Railroad crosses North Fork at Dyersburg.

V 17.

WATER GAUGES ON MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

These gauges were designed to secure information from continuous records, with a view to protection of the alluvial lands against overflow, the improvement of navigation, and to give correct reports of the stages of water for the benefit of river men and planters. They were ordered by joint resolution of Congress, approved February 21, 1871 (section 5252, Revised Statutes), viz:

SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas; and Alexandria, on the Red River; and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of $5,000.

All of the gauges directed by the foregoing resolution were established the latter part of 1871, except the one at Carrollton, La., established in January, 1872. A gauge was placed at the mouth of White River instead of at Napoleon, Ark., as the latter place was caving fast into the river. Two gauges were established at Louisville, Ky., one

being needed at the head and one at the foot of the falls, and at the request of the steamboat men a gauge was set up at Natchez, Miss.

A gauge was established at Nashville, Tenn., on Cumberland River, in August, 1873. Additional gauges were established on Red River, at Shreveport, La., Garland, Ark., and Fulton, Ark., in February, 1890, and one at Donaldsonville, La., on the Mississippi, in June, 1890.

The gauge at Rock Island, Ill., was discontinued April 30, 1879, because observations so far upstream were needed no longer, and the gauge at Fort Leavenworth, Kans., was abandoned November 30, 1886, but readings at the latter place have been continued by the Missouri River Commission.

In 1881, bulletins were erected at the stations on the Mississippi for the purpose of giving passing steamboats the stage of water at each reading of the gauge, and showing whether the river was rising, stationary, or falling. The size of the plates in the original bulletins was 20¾ by 24 inches, black figures on white ground, but in 1890 they were replaced by larger bulletins, $\frac{1}{16}$-inch sheet-iron plates, each 40 by 48 inches, white figures on black ground, which are large enough to be read easily with the naked eye at a distance of half a mile. The old bulletins were repaired and used in extending the service to the tributaries.

From 1871 to February, 1887, the gauges were read and bulletins changed at 8 a. m. daily, but since the latter date this has been done at 8 a. m. and 4 p. m. every day, in order to obtain greater uniformity and accuracy.

The engineer gauges are used by the Weather Bureau at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., Vicksburg, Miss., Nashville, Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark.

During the fiscal year ending June 30, 1892, observations were continued at the twenty-two gauges, located as follows: On Mississippi River at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of White River, Arkansas, Lake Providence, Louisiana, Vicksburg, Miss., Natchez, Miss., Red River Landing, La., Baton Rouge, La., Donaldsonville, La., and Carrollton (New Orleans), La.; on Ohio River at Louisville, Ky., head of falls and foot of falls; on Tennessee River at Florence, Ala.; on Cumberland River at Nashville, Tenn.; on White River at Jacksonport, Ark.; on Arkansas River at Little Rock, Ark.; and on Red River at Alexandria and Shreveport, La., and Garland and Fulton, Ark. The gauge readings are received at this office weekly, reviewed, consolidated, and sent to the secretary of the Mississippi River Commission, by whom they have been published to the end of the calendar year 1891.

Records of the daily readings were furnished the president of the Mississippi River Commission; copy of the Florence record was furnished the engineer officer in charge of Lower Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi; and copies of the records at various stations were furnished district officers and levee commissioners during the flood season.

The following gauges were inspected by Assistant Engineer John Ewens during the year, viz:

July.—(16th) Carrollton, La., gauge rebuilt from 0 to 20 foot mark; (20th) Alexandria, La.; (21st) Shreveport, La.; (27th) Garland, Ark.; (28th) Fulton, Ark., gauge rebuilt from 0 to 11.2 foot mark; (31st) Little Rock, Ark., bulletin moved downstream 300 feet to better location.

August.—(2d) Memphis, Tenn.; (3d) Helena, Ark.; (4th) mouth of White River, Arkansas, gauge rebuilt from 13 to 47.6 foot mark; (6th) Lake Providence, La., gauge rebuilt from 9 to 37 foot mark.

November.—(30th) Garland, Ark.

December.—(1st) Fulton, Ark., gauge rebuilt from 1 to 8.2 foot mark; (5th) Alexandria, La.; (7th) Shreveport, La., gauge rebuilt from —1.7 to 2.2 foot mark, and arrangements made for rebuilding entire gauge.

March.—(3d) Carrollton, La., gauge rebuilt from 0 to 17 foot mark and a new stone and pipe bench mark established; (6th) Donaldsonville, La.; (8th) Baton Rouge, La., gauge rebuilt from 17 to 37 foot mark; (9th) Red River Landing, La., gauge rebuilt from 25 to 50 foot mark; (10th) Natchez, Miss., gauge rebuilt from 20 to 50 foot mark; (21st) Lake Providence, La., gauge rebuilt from 18 to 44 foot mark; (23d) mouth of White River, Arkansas, gauge rebuilt from 24 to 34 foot mark; (24th) Helena, Ark., new bench mark established; (26th) Memphis, Tenn.; (28th) Little Rock, Ark.; (31st) Fulton, Ark.

April.—(2d) Garland, Ark.; (3d) Shreveport, La.; (4th) Alexandria, La.

The limited means available prevented the frequent and rigid inspections essential to accuracy of the readings and records, and for this reason the results of the year's work have not been as satisfactory as could be desired.

The service begun in 1871 has been extended and improved until it has grown to be a large and important system of collecting valuable information for the improvement of many streams, for giving correct river reports to those interested in navigation, prompt warnings to those living in sections subject to overflow, information to the planting interests of the alluvial valley, and for distributing and preserving the records for future use. As the value of the observations and the practical use of the bulletins become appreciated, requests are made by river men for new gauges or for bulletins at important stations on the tributaries.

Gauge stations have been established on tributary streams in connection with their improvement, some of which might be transferred to this service with benefit to all concerned. There are several gauges in each district on Mississippi River between St. Louis and New Orleans, the reports of which are sent to the secretary of the Commission, but the records of all can not be equally valuable, as the gauges are not inspected regularly or uniformly. Rigid inspection is necessary to insure careful observations, to maintain the gauge zeros invariable, and to a well ordered and efficient service, which can be secured in no other way without great cost, and for this reason the recommendation of former reports, that the entire gauge service should be under one management, is repeated in the interest of economy and good service.

Attention is invited to that portion of my last report regarding the decision, made in April, 1891, that section 6 of the river and harbor act of August 11, 1888, allows only $6,000 to be drawn during each fiscal year (pages 2016, 2017, Report Chief of Engineers, 1891), and also to the fact that during the two fiscal years preceding 1891 it was held that the amount available for each year was $9,600, and the recommendation is repeated that section 6 of the act of August 11, 1888, be amended to grant in unmistakable terms a permanent appropriation of such amount as may be necessary to do the work, not to exceed in the aggregate for each fiscal year the sum of $12,000, as per the following estimates, viz:

Wages of observers	$5,000
Repairs of gauges and bulletins	800
Pay and traveling expenses of inspector, and wages of extra help at gauge stations	2,700

Permanent bench marks	$300
Level connections	2,000
Record books, blanks, stationery, telegrams, etc	200
Office expenses	500
Mileage and transportation	500
Total	12,000

This amount would provide for the maintenance and perfection of the present gauges; a judicious extension of the service, by embracing all other gauges now on the Lower Mississippi and the principal ones on the tributaries, and establishing new ones at such places as may be deemed advisable; putting the gauges on the Lower Mississippi and its chief tributaries under one management and one system of inspection, with greater economy and advantage to the entire service. Frequent inspections could be made to prevent errors in the gauges and records, and gradual level connections could be obtained with the Cairo datum, the common reference plane of the Engineer Department and the Mississippi River Commission, to give the greatest value to the records.

It is urged also that the gaugings at or near St. Paul, Minn., which under the act of August 11, 1888, are to be paid for out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries, be provided for by a separate and distinct appropriation, as the gaugings are of a different kind, consisting of discharge measurements during the operation of the reservoirs at the headwaters of the Mississippi River, without connection with the gauges on the Lower Mississippi River and its tributaries, and, being in charge of another officer, their cost is not included in my estimates given above.

Comparison of flood of 1892 with highest water recorded since establishment of present gauges.

Gauge stations.	Year gauge was established.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean gulf level at Biloxi, Miss. (preliminary).*	Highest water previously recorded on present gauge.		Highest water during fiscal year ending June 30, 1892.		Relation to previous highest record.	
				Date.	Gauge reading.	Date.	Gauge reading.	Above.	Below.
		Feet.	Feet.		Feet.		Feet.	Feet.	Feet.
St. Louis, Mo	1871	400.23	378.97	June 26, 1883	34.80	May 19	35.95	1.15	......
Cairo, Ill	1871	290.84	269.58	Feb. 27, 1883	52.17	Apr. 28	48.29	......	3.88
Memphis, Tenn	1871	203.97	182.71	Mar. 23, 24, Apr. 4, 5, 1890.	35.60	May 2, 3	34.60	......	1.00
Helena, Ark	1871	161.98	140.72	Apr. 30, 1886	48.10	May 11	45.73	......	2.37
Mouth White River, Arkansas	1871	128.73	107.47	Mar. 31, 1890	50.40	June 1	49.27	......	1.13
Lake Providence, Louisiana	1871	89.62	68.36	Mar. 15, 1890	41.05	June 2	41.90	.85	......
Vicksburg, Miss	1871	66.04	44.78	Apr. 24, 25, 1890	49.05	June 2, 3	48.45	......	.60
Natchez, Miss	1871	36.89	15.63	Apr. 23, 1890	48.60	June 26	48.10	......	.50
Red River Landing, Louisiana	1871	23.85	2.59	....do	48.77	June 28	48.83	.06	......
Baton Rouge, La	1871	20.06	—1.20	Apr. 21, 22, 1890	36.58	....do	38.45	1.87	......
Donaldsonville, La.	1890	†19.71	†—1.55	Mar. 18, 20, 1891	27.90	June 13	30.15	2.25	......
Carrollton, La	1872	20.91	—0.35	Mar. 13, 17, 1890	16.13	June 10	17.35	1.22	......
Louisville, Ky. (upper)	1871	†419.76	†398.50	Feb. 16, 1884	46.60	Apr. 23	21.80	......	24.80
Louisville, Ky. (lower)	1871	†392.85	†371.59	....do	72.00	....do	47.40	......	24.60
Florence, Ala	1871	....	....	Jan. 22, 1882	29.60	Apr. 8	24.00	......	5.60
Nashville, Tenn	1873	....	....	....do	55.10	Apr. 26	38.80	......	16.30
Jacksonport, Ark	1871	....	....	Mar. 14, 1890	33.35	May 20	30.40	......	2.95
Little Rock, Ark	1871	241.50	220.24	Feb. 15, 1884	30.60	May 21	31.20	.60	......
Alexandria, La	1871	64.46	43.20	May 19, 1890	36.85	June 12, 13	38.25	1.40	......
Shreveport, La	1890	161.27	140.01	May 8, 1890	34.70	May 28	35.70	1.00	......
Garland, Ark	1890	228.44	202.18	Apr. 30, 1890	28.17	May 24, 25	28.40	.23	......
Fulton, Ark	1890	244.78	223.52	May 3, 1890	34.15	May 23, 24	34.85	.70	......

* Mississippi River Commission preliminary value, 21.26 feet above the Cairo datum plane.
† Preliminary value.

Itemized statement of expenditures during the fiscal year ending June 30, 1892, submitted in compliance with requirements of section 6 of river and harbor act of 1888.

Observations:		
Pay of 4 permanent gauge keepers from April 1, 1891, to June 30, 1891, inclusive	$195.00	
Pay of 19 permanent gauge keepers for the fiscal year 1892	3,360.00	
Pay of 1 permanent gauge keeper at Lake Providence, La., from July 1 to September 22, 1891, and from September 24, 1891, to June 30, 1892	179.25	
Pay of 1 permanent gauge keeper at Garland, Ark., from July 1 to December 31, 1891, and from February 6 to June 30, 1892	108.33	
		$3,842.58
Inspection and repairs:		
Pay of assistant engineer, 5 1/15 months, at $150	760.00	
Traveling expenses of assistant engineer while inspecting gauges	217.80	
Pay of employés hired to assist gauge inspector and to repair and paint gauges, etc	34.50	
Material for repairs of gauges	99.34	
Transportation of material for repairs of gauges	9.75	
One traveling case (for instruments, tools, etc.) for use of gauge inspector	18.00	
Putting compartments, tray, etc., in traveling case	6.00	
Two sets of branding dies for marking gauges	24.35	
Putting iron bands on 4 heavy wooden mauls used in driving gauge posts	4.00	
		1,173.74
Office expenses and contingencies:		
Pay of copyist, 3 7/15 months, at $60	208.00	
Gauge records	63.00	
Stationery	15.41	
Blue printing hydrographs	9.80	
Transportation of stationery, note books, and photograph camera	4.30	
Zinc tags for marking high water of 1892 at places where there are no gauges	2.50	
		303.01
Total		5,319.33

Outstanding liabilities July 1, 1892.

Telegrams, fiscal year 1890	$5.19
Telegrams, fiscal year 1891	.68
Telegrams, fiscal year 1892	1.05
Pay of deceased gauge keeper, St. Louis, Mo., July 1–17, 1890	11.00
Pay of deceased gauge keeper, Garland, Ark., January 1–31, 1892	10.00
	27.92

Money statement.

July 1, 1891, balance unexpended	$247.31
Amount allotted for project for fiscal year ending June 30, 1892, approved July 17, 1891	5,100.00
	5,347.31
June 30, 1892, amount expended during fiscal year	5,319.33
July 1, 1892, balance unexpended	27.98
July 1, 1892, outstanding liabilities	27.92
July 1, 1892, balance	.06
Amount that can be profitably expended in fiscal year ending June 30, 1894 } Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,000.00

V 18.

SURVEY OF CYPRESS BAYOU AND THE LAKES BETWEEN JEFFERSON, TEXAS, AND SHREVEPORT, LOUISIANA, TO ASCERTAIN IF NAVIGATION CAN BE MATERIALLY AND PERMANENTLY IMPROVED BY THE CONSTRUCTION OF LOCKS AND DAMS, AND THE PROBABLE COST THEREOF.

To comply with a resolution of the House of Representatives of February 6, 1890, I was directed to make a special report respecting the improvement of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La. This report, containing a review of all work done upon and plans proposed for improvement of this waterway, was submitted February 26, 1890, and published as House Ex. Doc. 252, Fifty first Congress, first session, and also as Appendix W 18, Report Chief of Engineers, 1890, pages 1914–1924. In concluding the report it was stated that the plan desired to be investigated by the people interested in navigation of Cypress Bayou and the lakes consisted essentially of the formation of a reservoir in the bayou proper and the lakes by constructing a dam and lock at the head of Sodo Lake and dredging a channel through the latter to Twelve-Mile Bayou or to Red River; that the success of such plan depended upon so many conditions that its feasibility could not be discussed until after a thorough survey, both in topography and precise levels; and that, as the country is a difficult one, the survey would be expensive, estimated at $10,000, or $12,000 if it should be found necessary to examine the outlets between the route and Upper Red River.

Acting upon this report, Congress ordered the survey made by the following item of river and harbor act of September 19, 1890, viz:

> The Secretary of War is hereby directed to cause a survey to be made of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., in order to ascertain if the navigation of the said bayou and lakes can be materially and permanently improved by the construction of such dams, and locks and dams, as may be necessary, and if found practicable the probable cost thereof, and for this purpose $10,000, or so much thereof as may be necessary, is hereby appropriated.

A progress report upon the survey was submitted February 6, 1892 (published in House Ex. Doc. No. 126, Fifty-second Congress, first session), and is repeated below, as the conditions remained unchanged at the close of the fiscal year.

PROGRESS REPORT UPON SURVEY OF CYPRESS BAYOU AND THE LAKES BETWEEN JEFFERSON, TEXAS, AND SHREVEPORT, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., February 6, 1892.

GENERAL: I have the honor to submit a progress report upon the survey of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport La., authorized by the act of September 19, 1890, "to ascertain if the navigation of said bayou and lakes can be materially and permanently improved by the construction of such dams, and locks and dams, as may be necessary."

There were three surveys authorized by the same act in this district, all of great importance, and requiring the highest degree of accuracy. Owing to the late date of the act and the impossibility of getting skilled men to carry on all of the surveys at the same time, it was judged best to organize one field party at Vicksburg for all, and begin with the survey of lower Yazoo River, which was commenced as soon as the projects required by law were approved, and continued until stopped by high water December 6. The party was then transferred to Cypress Bayou, the quarter boats of Red River survey having been fitted up in advance, and work commenced December 8. Progress was hindered throughout, high water rising in January and covering the low banks of the bayou and lakes, making it difficult to find stations for triangulation. The water rose from 10 feet at Shreveport, January 1, to 24 feet,

and remained high through February, but by April had fallen sufficiently to resume and finish the triangulation by the middle of the month, when the party was transferred to the survey of Red River.

The triangulation of Cypress Bayou covers the whole lake basin, and connects with the system of the Red River survey above Shreveport. The precise levels are connected through those of the Red River survey with the levels of the Coast Survey and Mississippi River Commission from Cairo to Biloxi. They were carried from the Shreveport bench to the hills above the south shore of Caddo Lake, and connected with the wye level lines from Jefferson down the bayou, the country being too rough for precise levels.

The notes have been revised and those of former surveys examined and used as far as possible and the work plotted in the field to insure corrections while the party was still at work, a draftsman being employed on the quarter boat during the progress of the survey. The maps were laid out in the office afterward on a scale of 1 to 10,000, and five of them have been finished.

The outline map herewith, scale 1 inch to 3 miles, shows the general scheme for the maps and the connections with Red River, the finished sheets being marked in full lines. The final adjustment of the map sheets will be made to cover the drainage basin to the best advantage, and a number of the map sheets of the Red River survey will be added to give the details of the bayou on the right bank as far as the head of the great raft. The profiles and sections have not been plotted, as the whole party has been engaged in pushing the survey of Red River to completion during the low water of the autumn and winter. A final discussion of any plan to give permanent navigation between Jefferson and Shreveport can not be had until the maps and profiles are made, and ought to be postponed until the survey of Red River is completed, as the permanent navigation desired is from Jefferson to any ports which may be reached from Shreveport, and not simply a waterway between the two cities. The maximum depth that can be given for permanent navigation of Red River is one of the factors, and the natural drainage of the lake basin another, which must be known for a plan of improvement by locks and dams.

Formerly, during the raft period, the lake district was filled by overflow or through bayous, or the canals cut to give passage around the raft, but since the raft has been removed the bayous and abandoned canals have been filling up; and it is the intention of the United States and of the State of Louisiana to close them and make the levee system continuous from the hills near the Arkansas line downstream, so that in a few years Cypress Bayou and the lakes will have no water supply except from backwater through Twelve-Mile Bayou and its own drainage. The work of closing these bayous that formerly depleted Red River in the higher stages was begun in earnest in September, 1891, by the United States building a high dam across the Sale and Murphy canal, near Bargetown, which was extended by a new State levee to the main line on Red River above.

The necessity of covering so large an area of the basin and of examining the outlets from Red River which used to feed the lakes is now plain, and it is also evident that until the drainage has been computed the feasibility of giving any navigation to Jefferson by locks and dams can not be discussed understandingly. The levels from Shreveport to Jefferson, however, give certain information which indicates that if the water supply should prove ample the cost of the necessary locks and dams would be very considerable. The rise and fall of the river at Shreveport is about 11 meters, or say 36 feet, that at Jefferson 24¼ feet, and the difference between the gauge marks at the two cities is 16 feet at high water and 26½ feet at low water; while the total fall from high water at Jefferson to low water at Shreveport is 52 feet. The people interested in navigating the lakes and Red River will not be satisfied with a navigation of 3 feet, as formerly proposed, but would expect as good a navigation as may be found practicable in Red River, say not less than 5 feet clear navigable depth in low water. This would require locks for the largest boats now in Red River or that might reasonably be expected, probably not less than 250 feet length by 60 feet width, with the maximum lift the soil would allow.

The difference in elevation given above shows that at least two locks would be required and that they would have to be of the most substantial construction and carried above the highest floods, in order to be available in high water, unless it should appear that movable dams could be employed.

On the other hand, when the outlets shall have been closed, the high-water limit in Cypress Bayou and the lakes will be lowered, though how much is a matter of speculation, and this would change the conditions of the problem in almost every particular. It seems almost certain that the effect of confining Red River will be to increase its carrying power, lower its high and low water lines by deepening the channel, and consequently hastening the draining of the lake district.

The same level lines make it possible to review Maj. Howell's plan of impounding the water in the lakes by a dam from Albany Point on Sodo Lake to Gold Point on Red River, and making a cut above the dam 30 feet wide at bottom to a depth of

6feet, the cost of the whole being estimated at $372,580, if given in one appropriation. The subject will be found discussed at length in the Report of the Chief of Engineers for 1890, pages 1914 to 1924, in the form of a digest of all the reports upon Cypress Bayou since 1870. Fortunately the plan did not meet with the approval of Congress. Had it been carried out the water from Red River would not now reach the zero of the Jefferson gauge at low water. This statement is not made to reflect upon Maj. Howell, but rather to show the importance of deliberation in dealing with problems like the one in hand. Maj. Howell was hurried into submitting his report without checking the levels, and he was also engaged in the removal of the great raft, which would of necessity change the conditions under which he expected his plan to succeed, but how great that change would be neither he nor any other engineer could have foreseen.

In comparing the levels of Maj. Howell's survey, those of Red River and Cypress Bayou survey of 1890–'91 must be taken as standard, and they may be accepted with perfect confidence, for the main line, beginning at the Coast Survey bench 215 at Delta Point, has been carried by the method of precision across Louisiana and down Red River, closing upon the Coast Survey bench at Smithland, below the mouth of Red River, with a discrepancy of less than 1 inch, the distance being over 700 miles.

The precise and wye levels from Shreveport to Jefferson reveal an error of nearly 2 feet in the levels upon which Maj. Howell relied, and the hydrographs of Red River and the lakes, combined and given on the sheet herewith, show that the line of low water at the time of Maj. Howell's survey was nearly 3 feet higher at Gold Point than in 1886–'87. The hydrograph is especially interesting, as the part of the river covered by it is that which was blocked by the great raft, and the difference, which might otherwise be thought an accident or an error in levels at Gold Point, is even greater as the line is followed upstream.

The high-water limit was obtained in the following way: When the flood of 1890 came on in Red River, dispatches from the highest stations gave warning that it would be very great, and accordingly small zinc plates, marked H. W. 1890, were sent from this office to a great number of people living on Red River from Fulton down, with request that they nail them up on trees or buildings to mark the high water of that year and send descriptions to this office on prepared blanks as soon as convenient after the water fell. In this way a great number of points were got along the river, and an assistant was sent out with a level to connect them with the main line of levels. The low-water lines were obtained by gauges, both permanent and temporary, and by direct levels to the water surface during the various surveys.

The upper line from Garland to Shreveport and below represents the limit of the flood of 1890, the highest that we have actual record of. The line just below from Collins Bluff to Shreveport shows the low water of 1871, derived from Maj. Howell's levels corrected for actual error, and the line from Garland to Shreveport just beneath is the low water as found from the gauges and the levels of 1886–'87. The dotted line from Collins Bluff to Shreveport indicates the possible limit of low water as the raft continues to be removed and the bottom to scour. The intermediate lines are the high and low water limits in Cypress Bayou and the lakes, determined by the precise levels of 1890–'91, and show that the zero of the Jefferson gauge, which is the low water, is higher than the low water of 1886–'87 at Gold Point. The differences between the low-water line of 1871 and that of 1886 show how great the improvement has been since the raft was removed, and indicate the progress that may be looked for. The hydrograph shows also that it is exceedingly doubtful whether it would be safe to follow Maj. Howell's plan by changing the line of dam and cut to some point above the site chosen by him, say at the head of Cottonwood Bayou, for though it would be possible to gain a low-water depth of 6 feet at Jefferson by opening Cottonwood Bayou and building a dam across the lake and a levee along the lower side of Cottonwood Bayou to Red River, it would not be possible to say how long the improvement would last. Moreover, the farther up Red River the entrance to Cypress Bayou and the lakes is made, the greater the difficulty in maintaining a deep-water connection by way of Red River to Shreveport.

From the rate at which the low-water line has fallen at Cottonwood Bayou since 1871, it seems probable that it may fall quite as much in the next twenty years, so that if a dam were built and the route opened through Cottonwood Bayou to the lakes, the navigable depth to Jefferson would by that time have reached the limit of usefulness.

The matter is one of grave importance and should not be decided without further investigation. Gauges should be set up at frequent intervals through the raft portion of Red River to get the actual low-water surface, and the lines along Cottonwood Bayou and those just above should be examined, together with boring at the probable sites for the dam and levee, and in the mean time the maps should be finished and all the information obtained by the levels plotted, with profiles and sections. As the full amount of the estimate was not granted, I recommend the sum of $2,500 to continue the examination. It may be stated that Maj. Howell contemplated a dam

at the flood height with a spill way about 9 feet lower, while for the route through Cottonwood Bayou it would not be absolutely necessary to raise the dam above a 10-foot stage (except for the benefit of Red River), but only to build the levee to full height. It is also probable that Cottonwood Bayou could be opened to the same capacity as Upper Cypress Bayou at much less cost than the cut proposed by Maj. Howell. Both lines are indicated on the outline map herewith.

As all of the water retained by the dam and levee would return to Red River when the latter should fall below the height corresponding to the crest of the dam, the route through Cottonwood Bayou should keep itself free and should not be regarded as an injurious outlet, such as are those above which are to be closed, and therefore not opposed to the principles laid down for the improvement of Red River. Cottonwood Bayou would be closed as effectually by the dam and levee as by a dam across its mouth, and the plan of giving a navigable depth of 6 feet to Jefferson may be regarded as in effect the construction of a great reservoir to hold flood waters, somewhat after the plan of those advocated for the Upper Mississippi River.

Very respectfully, your obedient servant,

J. H. WILLARD,
Capt., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Owing to an error in elevations, etc., upon the hydrograph sent with my report of February 6, 1892, a corrected copy is submitted herewith, with request that it be reprinted in the Annual Report.

Since the report of February 6, all the maps have been finished except that covering the city of Jefferson, the index map, and the title sheet. There remain to be plotted the profiles and sections and the discharge measurements. If a new appropriation should be made, it is proposed to expend it in developing the high-water route from Red River through Cottonwood Bayou, and to make borings and sections along the probable sites for levees, dams, or locks and dams. The flood of 1892 was so much greater in Red River above Shreveport than any other, so far as is known, that it will be important to connect as many high-water marks as possible with permanent benches already established by this survey and that of Red River to fix the heights of any works of construction that may be found practicable; and also to determine as far as possible the low-water limit at Jefferson and at the mouth of Cottonwood Bayou. All of this work can be done to best advantage in low water, and, if possible, when cold weather reduces the danger of sickness. The estimate of $2,500 for completing the survey is renewed.

Money statement.

July 1, 1891, balance unexpended	$102.01
June 30, 1892, amount expended during fiscal year	96.00
July 1, 1892, balance unexpended	6.01
July 1, 1892, outstanding liabilities	4.98
July 1, 1892, balance available	1.03
Amount appropriated by act approved July 13, 1892	2,000.00
Amount available for fiscal year ending June 30, 1893	2,001.03
Amount (estimated) required for completion of existing project	500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

APPENDIX W.

IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing obstructions in Arkansas River.
2. Arkansas River.
3. Fourche Le Fevre River, Arkansas.
4. Petit Jean River, Arkansas.
5. White River, Arkansas.
6. Cache River, Arkansas.
7. Little Red River, Arkansas.
8. Black River, Arkansas and Missouri.
9. Black River, Missouri.
10. St. Francis River, Arkansas.
11. St. Francis River, Missouri.
12. Little River, Missouri.

EXAMINATION AND SURVEY.

13. Clarendon and the Lower White River, Arkansas.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1892.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1892, upon the works under my charge.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

W 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream, but from the delta-like character of its lower portion and the tendencies now manifest in its upper reaches, it may be inferred upon very substantial grounds that

shifting sand bars, numerous drift piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches. The records of this office indicate that, except at a few places, such as Pine Bluff, Ark., and Fort Smith, Ark., the general plan of improvement has consisted of snagging operations, which include cutting overhanging trees and in building wing dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river. For the exceptions noted attention is respectfully invited to reports upon these special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections. The grand total of all these appropriations up to June 30, 1891, amount to $485,251.37. Of this there had been expended up to June 30, 1890, $391,288.67, exclusive of certain sums aggregating over $100,000 that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Ind. T., to Big Rock, Ark., 3 miles above Little Rock, Ark., in the year 1870, and also another series of maps from Wichita, Kans., to Fort Gibson, Ind. T., from a survey in 1884. From the nature of the case the balance of the work has been each year a repetition of that of preceding years. One iron-hulled snag boat and one light-draft wooden snag boat, with all the appliances necessary for snagging operations were the visible signs of the balance, while the gratitude of those interested in the navigation of the river for a navigation rendered yearly less and less dangerous by the operations of these two boats is the only evidence existing, and the only evidence to be expected, of work that must be done in a stream like this, until by some system of permanence caving banks no longer exist and the annual quota of snags is no longer furnished.

The most economical management of snag boats requires not less than $35,000 annually to give absolutely indispensable aid to navigation, a navigation in which a vast amount of commerce is vitally interested. During the fiscal year ending June 30, 1892, $10,327 was expended in removing 787 snags, cutting 544 overhanging trees, and destroying four drift piles, and in the care and running expenses of the United States snag boat *Wichita*. The season's operations extended from July 1 to October 24, 1891. A portion of this time the river was too high for effective snagging operations. For the first time in the history of snagging operations on the Arkansas River, the most dangerous snags in the low-water channel between Webbers Falls, Indian Territory, and the mouth of the river were removed by a boat that could get at them, drawing less water than the packets. It is the beginning of systematic snagging operations at extreme low water for which this office has labored for the last seven years. The navigators of the river are delighted with the results. The only drawback to the perfect triumph of a steady policy of operations only at or near low water lay in the extremely small size of the appropriation. As stated in my last annual report, if on or about the opening of the fiscal year beginning July 1, 1892, the sum of $70,000 could be in hand and an effective clearance of the Arkansas River could be secured, this would render it possible with the advance in the permanent improvements to maintain the channel free

from snags by taking the two snag boats as towboats on the permanent improvements and using them for snagging operations such few times as might be necessary.

Further, the time has come in the progress of improvements on this river when it is my duty to recommend that, if possible, the money for snagging be appropriated under the same head as that for the permanent improvement of the river, as it will save in engineering and office expenses, as now two separate sets of papers have to be kept, whereas only one set of papers need be kept, and yet so much money might always be used for snagging operations, the papers showing all the time exactly to what purpose moneys were applied. This would practically increase the plant available for both works, and will be a matter of economy in many ways. The goal that has been so long sought in reference to the opening of the Arkansas River is rapidly being neared. It has taken persistent effort and strict adherence to a systematic plan in the face of much adverse criticism; but two years more of the same work will show that even with small appropriations, if there is an economical following of carefully devised plan, a river very thickly populated with snags may be eventually opened.

Commerce.—For information upon this point see report for "improving Arkansas River, Arkansas."

Money statement.

July 1, 1891, balance unexpended	$12,344.46
June 30, 1892, amount expended during fiscal year	10,327.00
July 1, 1892, balance unexpended	2,017.46
July 1, 1892, outstanding liabilities	1.25
July 1, 1892, balance available	2,016.21
Amount appropriated by act approved July 13, 1892	20,000.00
Amount available for fiscal year ending June 30, 1893	22,016.21
Amount (estimated) required for completion of existing project, annually	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	70,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay roll	$6,904.95
General supplies	860.84
Subsistence supplies	1,707.97
Lumber	15.92
Fuel	552.30
Traveling expenses	30.70
Transportation	18.90
Rent	80.00
Stationery	57.23
Medicine	86.66
Total	10,315.47
Reserved in United States Treasury for freight charges	11.53
Grand total	10,327.00

W 2.

IMPROVEMENT OF ARKANSAS RIVER.

Work during the past season has been carried on under three different acts of Congress.

By act approved August 5, 1886, $75,000 was appropriated under this head, its distribution being indicated in the following words and figures:

Improving the Arkansas River, Arkansas: Continuing improvement, according to the plans and recommendations in Appendix V 13, Ex. Doc., No. 1, Forty-ninth Congress of which there are to be expended $8,000 at Pine Bluff; $13,000 at Fort Smith, and $10,000 at Dardanelle, or so much thereof under these sums, respectively, as may be necessary at these points.

All of this money, except a small sum out of the $10,000 for Dardanelle, having been expended prior to June 30, 1890, it is only necessary to summarize the project for Dardanelle, as follows: At Dardanelle the $10,000 is to be expended in erecting a permeable dike above and opposite the town, in such a position as to remove the sand bar now in front of the wharves.

By act which became a law August 11, 1888, $150,000 was appropriated under this head, its distribution being indicated in the following words and figures:

Improving Arkansas River, Arkansas: Continuing improvement, $150,000: *Provided*, That nothing herein contained shall authorize the Secretary of War to enter upon project of improvement of said river as set forth in the report of the Board of Engineers on improvement of Arkansas River, from Witchita, Kans., to its mouth, dated New York City, March 16, 1888, and contained in House Ex. Doc. No. 234, Fiftieth Congress, first session: *Provided*, That the Secretary of War shall expend the appropriation under this head with reference to the final improvement of this river as contemplated in the Report of the Chief of Engineers for the year ending June 30, 1885, and as authorized in the act for the improvement of rivers and harbors, approved August 5, 1886, and in House Ex. Doc. No. 90, Forty-ninth Congress, first session, said methods to be applied as the Secretary of War may direct at such points between Wichita, Kans., and the navigable mouth of the Arkansas River at its junction with the Mississippi River, as he may deem for the best interests of commerce. And all moneys now to the credit of different sections of the Arkansas River, other than the appropriations for the operating of the snag boats, shall be available for use under this head; and in future the engineer in charge of this work and the Secretary of War shall make report upon the progress and needs of this work under this head instead of reporting upon disconnected projects as heretofore. Nothing herein contained shall be understood to prevent the Secretary of War from applying any part or all funds previously appropriated for use at Fort Smith, Dardanelle, in Pine Bluff Reach, or from expending not exceeding $8,000 as a contingent fund for expenditure in Pine Bluff reach.

By act approved September 19, 1890, $180,000 were appropriated, its distribution being indicated as follows:

Improving Arkansas River, Arkansas: Continuing improvement from Wichita, Kans., to its mouth, $180,000.

The approved projects for the expenditure of this sum may be summarized as follows:

At Van Buren the $4,000 to be expended in erecting a permeable dike at a suitable point a little above the town and upon the opposite side of the river, to contract the channel and prevent it from leaving the city wharves. From Fort Gibson, Ind. T., to the mouth of the river, the balance to be expended in the erection of permeable dikes, and in one instance by rock excavation at the worst places, or the places at which serious interference with the largest amount of commerce occurs, so far as the amount of the appropriation will permit,

looking toward the permanent improvement of the river, to give a channel at least 6 feet deep and 200 feet wide from Little Rock to the mouth of the river, via White River Cut-off, as provided under the act of August 5, 1886, and an all-year-round depth of water of at least 2 feet from Little Rock, Ark., to Fort Gibson, Ind. T., under all acts, the work to be carried on by hired labor and the purchase of material in open market, as this is believed to be the most economical and advantageous to the Government. Before operations were begun at Dardanelle, a bad bar had formed along the town front, cutting off all approach to either wharf at low water or at medium stage. From Fort Gibson to the mouth of the river, the river consists of alternating bars and caving banks, with crossings more or less troublesome at low water, a few of the latter operating to effectually close the river to navigation at extreme low water for even boats drawing but 2 feet of water. In all cases of this kind the crossings occur at points at which, while the river is falling from a 10-foot stage to extreme low water, its water is so widely spread that it develops no channel at any point.

Seven years of careful study of this river, combined with the testimony of the navigators of the river, all point to this fact, that the crossings are deep or shallow in proportion as the water is narrow or broad at or above the crossing, and that a very slight contraction, such as that produced by a few logs, tree tops, and sometimes clay lumps, just sufficient to give defining power to the current, will convert a bad crossing into a good one.

First in order of appropriations and projects, works at Dardanelle and Van Buren should be reported upon.

Except visits of inspection, no work has been done at either place. Last report showed satisfactory progress at Dardanelle; no heavy rise occurred until late in the present fiscal year that would cause any marked changes, and June 30, 1892, finds the water still too high to report progress or probable future operations. From present indications it would seem advisable to spend the small balance strengthening the works at that point, and complete the improvement of this reach, under proper projects, part and parcel of the works of general improvement. The same may be said in reference to special works at Van Buren. With the exception of plant that might be sold to the general improvement works, there are no funds available for this special work, and during the coming fiscal year proper steps will be taken to merge this in the general work and make no further special report. There is no doubt that the dike already built will need extending some 100 feet or more. Such extension will not fill up the channel in the draw if the present results form any guide. The problem here is a very nice one, inasmuch as there is danger of throwing a bar under the drawspan of the bridge in the attempt to throw the channel against the wharf. The dike will be extended during the coming season under proper authority as a part of the general plan for the improvement of the river. This brings this report to the improvement of the Arkansas River as a whole.

Before entering upon this report attention is briefly invited to the fact that the work covers at least 710 miles of river, and there has been $330,000 wherewith to work, where $900,000 was asked for; or, to put it in another way, the engineer is expected to enter upon the improvement of the river with about $470 per mile, when the least estimate calls for over $14,000 per mile. Facing these conditions, evidently about the only thing to be done is to select the places that affect the

greatest amount of commerce and improve them as far as the amount appropriated will permit.

Acting upon this plan, during the fiscal year ending June 30, 1892, $119,630.65 have been expended, viz: Two dikes 400 feet long, 4 feet above low water, with foot mattress 60 feet wide, constructed of alternate layers of stone and brush, were completed at a point 30 miles above Fort Smith, Ark.

The work at Moores Rocks, about 30 miles below Fort Smith, consisted originally of the cutting of a channel 75 feet by 425 feet, with a depth of 2 feet below low-water mark, through a rock reef, requiring the excavation of 1,997 cubic yards of rock.

During the fiscal year ending June 30, 1893, 926 cubic yards of rock have been excavated, which, with 270 cubic yards excavated during the fiscal year ending June 30, 1891, makes a total of 1,196 cubic yards excavated to date, and leaves 801 cubic yards yet to be excavated to complete the work.

High water retarded the work at different times and cold weather suspended the work in October, 1891. High water and cold weather have prevented resumption of work since. During recent high water the cofferdam at this point was floated out, but most of the material was secured.

At Big Rock stone quarry, 3 miles above Little Rock, 8,376 cubic yards of rock have been quarried, and of this amount 6,754 cubic yards have been barged to Pine Bluff.

At Pine Bluff two additional dikes, Nos. 5 and 6, were built, each 150 feet long and 17 feet above low-water mark.

Dikes A°, A, and No. 2 received much needed repairs, and Dikes 3 and 4 were repaired. No. 4 made a permanent rock dike, and No. 3 advanced towards completion in like manner.

Early in October, 1891, the work below Mallorys Ditch, below Pine Bluff, according to project approved August 25, 1891, was commenced. This work consisted of weaving a continuous mattress 125 feet to 150 feet wide from Mallorys Ditch to a point 1 mile below, laid from low-water line along the bank to the bottom of the river, and securely weighted down with rock, and the bank graded to a 10-foot stage and riprapped with rock to a depth of 1 foot. This work was completed April 1, 1892. The riprapping, however, was carried down to within 700 feet of the end of the mattress only.

Over 4,000 cubic yards of rock have been barged from Big Rock quarry, near Little Rock, and stored on the high bank at Pine Bluff, to be used in further improvements at that point. During October, 1891, special surveys were made at and in the vicinity of Pine Bluff, and in December and January the same was done at Fort Smith and at Little Rock, and velocity observations were taken at Fort Smith and Little Rock during the extreme high water of May, 1892, to determine the velocity discharge.

In addition to the above work, 10 barges, 60 feet by 20 feet, 1 pile-driver barge, 6 feet by 20 feet, thoroughly equipped as a water pile-driver, and 1 quarter-boat, 90 feet by 20 feet, have been built, besides various additions made to the machinery of the plant; and the dikes above Baring Cross Bridge at Little Rock have been in part repaired. The unprecedented high water of the past year has greatly impeded the work along the entire line. As to the results of the work, nothing but a condensed summary of them can be given within the limits of this report.

The work at Moores Rocks will be completed within the estimate, notwithstanding the interruption.

The dikes that were erected above Fort Smith have given results that were spoken of by the Division Engineer as being satisfactory. It is too soon to make any report upon those erected 30 miles above. It will be necessary to erect 2 more dikes above the Baring Cross Bridge at Little Rock, in order to keep the channel through the draw of the bridge.

The contraction works below the Little Rock and Fort Smith Railway Bridge at Little Rock, erected in former years, have stood long enough to have something of a history, and there is submitted herewith a tracing which shows the cross sections of the channel during the various years therein noted.

This sets forth facts to the eye, rendering an elaborate memoir unnecessary. The same may be said of the tracing, which shows the same conditions just above Fort Smith. The appropriation being small, complete results can not be attained or expected anywhere. Where the works have come anywhere near the number required in the complete plant there are indications that the total number of works, including the dikes and revetment work, will produce the results desired. The dangerous and troublesome bend, extending from above the town of Pine Bluff to one mile below Mallorys Ditch, has enough works in it now to hold the river in check in the entire bend. The mile of revetment work over the portion where there was no quicksand has been successful for the entire mile without a break, and this under the test of the highest water known since 1844. From the upper end of this revetment to the upper end of the town of Pine Bluff, which no longer enters now as a factor in the improvement, a layer of quicksand underlies the bank. The dikes erected along this front are rapidly nearing completion, as originally contemplated, and during this extraordinary rise have also prevented any marked inroads on the part of the river. And it now would seem that when they are all made solid, which can be done at a slight expense, as contemplated in existing projects, this bend will be completed and will very materially aid the works located some 3 miles below.

As to the work proposed, it may be said that this is already a matter of printed record, based upon regular plans and estimates, which are supplemented for each reach of the river by special projects prepared under special surveys prior to entering upon the work. The policy pursued now is to fix upon points or reaches that can probably be entirely completed with the amount appropriated, and finish them, rather than do a little work here and there, which shall form at best only a part of the work that should be done at these points.

As a matter of plain duty it must be stated that prompt results are not to be expected with only \$150,000 or \$180,000 for two years' work, when \$1,000,000 could be profitably expended in that time. The engineer in this way spends more time in the vain effort trying to make both ends meet than in actual engineering study or development of the works. Fully \$100,000 ought to be expended in the plant at once. There are not barges, pile-drivers, and steamboats enough to do economical work. Again, material and labor is advancing very rapidly in price, and it will cost one-third more to do the work on this account. If anything like economical results are expected, at least \$1,000,000 should be available for the fiscal year ending June 30, 1894, and it will require \$3,472,479 to complete the improvement in accord with the

original plan. This is not a fancy estimate, but close calculation, borne out by eight years of unremitting labor.

In connection with this river I must again respectfully invite attention to the wonderful development of this State and the natural tendency of all this to make Little Rock a great commercial center. All the statistics connected with my reports bear upon this more or less. As one reach of the river under consideration has Little Rock at its head, the great importance of these works becomes more apparent. A careful study of statistics for six years convinces me that the State of Arkansas will, ere long, rise many files in the rank of the States, and public improvements will return manifold their costs in material benefit to the entire State.

The amount stated above as being required to complete the improvement only refers to the reach from Fort Gibson to the mouth. If the improvement is to be extended from Arkansas City, Kans., to the mouth of the river, there must be added for the reach from Arkansas City, Kans., to Fort Gibson, Ind. T., $1,696,900.

Commerce.—There is practically nothing new in regard to commerce not fully covered in my last annual report. A great many circulars were sent out, but owing to the flood excitement, depression of trade, or some reason not clearly known, there has not been the united effort to secure data, and I don't think it worth while to simply go all the ground over again that was covered last year, as that is all a matter of printed record and can be referred to.

Money statement.

July 1, 1891, balance unexpended	$157, 100. 81
Deposited to credit of Capt. H. S. Taber, Corps of Engineers	.50
	157, 101. 31
June 30, 1892, amount expended during fiscal year	119, 630. 65
July 1, 1892, balance unexpended	37, 470. 66
July 1, 1892, outstanding liabilities	14, 228. 49
July 1, 1892, balance available	23, 242. 17
Amount appropriated by act approved July 13, 1892	250, 000. 00
Amount available for fiscal year ending June 30, 1893	273, 242. 17
Amount (estimated) required for completion of existing project	3, 223, 479. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1, 000, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Expense account.

Pay roll	$68, 925. 93
General supplies	7, 259. 90
Subsistence supplies	14, 033. 63
Lumber	4, 625. 63
Fuel	5, 355. 90
Traveling expenses	971. 33
Stationery	334. 57
Transportation	552. 23
Rent	280. 00
Medicine	72. 77
Piling brush and poles	8, 241. 97
Stone	6, 060. 17
Rent of skiff and pump	4. 00

Flags	$16.50
Engine, boiler, and hammer	510.00
Steel rails	164.06
Skiff and oars	40.00
Steam capstan	321.85
Steam pump	116.00
Total	117,886.44
Reserved in United States Treasury for freight charges	1,046.74
Deposited to credit of United States Treasury	147.47
Transferred, as per letter, Chief of Engineers, April 11, 1892	550.00
Grand total	119,630.65

W 3.

IMPROVEMENT OF FOURCHE LE FEVRE RIVER, ARKANSAS.

The improvement of this stream was begun in 1879 under the act approved March 3, 1879. Prior to any improvement its channel was choked with snags, logs, and drifts, and heavy timber overhung its banks. Several bad shoals also impeded navigation.

Up to June 30, 1886, $21,000 had been expended in removing the greater part of the obstructions, though the shoals and now and then a snag that had washed in since work was suspended in December, 1882, still offered serious obstacles to navigation at medium stages of water.

By act approved August 5, 1886, $5,000 were appropriated for removing rock shoals, situated about 4 miles below Perryville. At the close of the fiscal year ending June 30, 1888, this sum had been expended, completing a channel about 500 yards long, 30 feet wide, and 2 feet deep at low water through this shoal.

From June 30, 1888, to September 19, 1890, no appropriations were made for this work.

By act approved September 19, 1890, $7,500 were appropriated. The approved project for its expenditure provides for the building and equipping of a hand-propelled snag boat of the *A. B. Johnson* model at a cost not to exceed $4,000; that it be operated for four months, if possible and necessary, at or near extreme low water, in removing accumulated obstructions in the way of snags, logs, and drift piles, and also landslides, and certain bowlders on Piney Shoals and $450 to be expended in making a square section through May Shoals, in the place of the present reversed arch, which will not permit a square-bowed flatboat to pass; and take out a portion of a rock at Red Ferry, which lies like a whale's back and offers a very narrow channel to steamboats. All this to provide for high and medium stage navigation, low-water navigation is out of the question, except say for 26 miles from its mouth to Piny Shoals.

During the fiscal year ending June 30, 1891, $2,448.70 was expended in building a hand-propelled light-draft snag boat after the *A. B. Johnson* model. This boat is to be operated only at or near extreme low water. During the year no such water occurred. During the month of August, 1891, the water having reached a proper stage, the snag boat was thoroughly equipped with crew and supplies and sent to the field of operations.

The whaleback rock at Red Ferry was removed to the depth of 5

feet by taking out 90 cubic yards of rock. The square section through May Shoal was completed by the removal of 373 cubic yards of rock and gravel. Piny Shoals was cleared of obstructions by the removal of 61 snags, 31 logs, and 50 cubic yards of rock, cutting 825 overhanging trees and deadening 34. The total work for the season consists of the removal of 1,326 snags and stumps, 4 large drift piles, 923 cubic yards of rock and gravel, several land slides, cutting 15,559 overhanging trees and deadening 1,185, thus giving the river a high and medium stage navigation from the mouth to Perryville Landing, a distance of about 30 miles.

During the fiscal year ending June 30, 1892, $3,743.33 was expended for the above work and care of property and records. Most careful attention was given to the operations of the boat, and I am happy to state she has sustained the record heretofore made by this class of snag boats.

The present appropriation practically meets all the demands of commerce upon the river. It is probable that after a while additional snagging operations may be required and certain improvements made through the shoals, as this valley settles up and the increased commerce warrants the same.

Commerce.—No new data has been secured in regard to commerce since last report, though diligent efforts have been made to do so.

Money statement.

July 1, 1891, balance unexpended	$5,051.30
June 30, 1892, amount expended during fiscal year	3,743.33
July 1, 1892, balance unexpended	1,307.97
July 1, 1892, outstanding liabilities	50.00
July 1, 1892, balance available	1,257.97

Expense account.

Pay roll	$2,378.60
General supplies	606.21
Subsistence supplies	457.43
Fuel	36.50
Traveling expenses	25.50
Stationery	9.50
Medicine	1.44
Transportation	10.90
Skiff and oars	20.00
Boiler	190.00
Reserved in United States Treasury for freight charges	7.25
Total	3,743.33

W 4.

IMPROVEMENT OF PETIT JEAN RIVER, ARKANSAS.

Before improvement this river was obstructed with snags, logs, drift-piles, overhanging trees, and shoals. The original project for improvement contemplated rendering it navigable during high and medium stages of water as high as Danville, Ark., by cutting the overhanging

trees and cutting up the snags, logs, and drift. The fall in the river is so great that nothing could be done to improve the shoals. The first appropriation ever made for the river was that of the act approved August 5, 1886, amounting to $3,500—one-half the estimate, $7,000. This amount was expended prior to June 30, 1888, in completing the work of improvement to Rocky Crossing, or about one-half the distance. The act which became a law August 11, 1888, appropriated $2,500 and provides for continuing the improvement below the iron bridge at Rocky Crossing. It will be seen that this is a departure from the original project and contemplates entering upon an improvement of a semipermanent character. This reach of river was accordingly visited in person and a new project prepared and duly approved. This project provided that $2,500 be expended below Rocky Crossing in removing timber from the low-water channel and in removing a small portion of the ledges at Slaty Crossing and Robinsons Ridge, so as to prolong the season of navigation. After many delays, fully explained in reports of former years, the work under the latter project was completed during the fiscal year ending June 30, 1891. The advantages given commerce by these improvements have been fully set forth in former reports.

It is my duty as engineer officer in charge to renew the recommendations of improving the river from Rocky Crossing to Danville, Ark., according to the original project. Three thousand five hundred dollars will be required for this purpose. In this connection attention is respectfully invited to my reports of the last two years. The entire river to Danville will some day be a valuable artery of commerce, and the bridge to Rocky Crossing, which now obstructs its free and safe navigation, should be made to comply with the law at as early a date as possible.

Commerce.—There has been no new data secured in regard to commerce since the report for last year.

Money statement.

Amount appropriated by act approved July 13, 1892 .... $3,500

W 5.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

Prior to improvement this river was much choked with snags, drift-piles, and logs, in its lower portion, and from Batesville up, gravel bars, rocky shoals, channel bowlders, and overhanging trees impeded navigation. The originally adopted project consisted in snagging operations, blasting of ledges and bowlders, and dam building to remove gravel bars, or to close chutes from time to time, as appropriation warranted and commerce required.

The first separate appropriation for this river was made by act approved July 5, 1884. At the time it was passed the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain. From Buffalo Shoals to Forsyth, Mo., there were many fine reaches of river, but the depth of water on Buffalo Shoals and others, less dan-

gerous, prevented any navigation at ordinary stages of water. This river has been united so often with the St. Francis, and again, once with the Black and St. Francis and once with the Black and Little Red, that it is impossible to give exactly how much had been expended upon the White River to June 30, 1884. After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000 and not over $200,000. This estimate should be given a weight of 8 in a scale of 10. The project for expending the appropriations made by acts of July 5, 1884, August 5, 1886, and August 11, 1888, provided for the removal of snags, bowlders, and other obstructions to navigation, building wing-dams to improve shoals, repairs to and care of plant, and survey of river, as provided for in the acts, with a view to its permanent improvement, from Forsyth, Mo., to its mouth.

Up to June 30, 1891, $88,290.74 had been expended. This completed the survey, plotted the notes, published the maps, and effectually improved some of the most dangerous shoals between Buffalo Shoals and Newport, Ark., gave much relief to navigation by removing the most dangerous snags from Batesville to the mouth of the river, constructed and equipped six barges, one floating pile-driver, cared for the property, and partly completed a dike at Newport.

During the fiscal year ending June 30, 1892, $15,190.80 were expended. Work was continued from a point reached by last season's work at Batesville Cut-off and carried forward to the town of Newport, a distance of about 50 miles. During the season the following shoals were improved: Cornwall Shoals, Cato Shoals, Saffold Shoals, Hagglestooth Shoals, Cleghorn Shoals, Rock Boat Shoals, and Black Island Shoals. Building 1,900 feet of dams, requiring for their construction 2,844 cubic yards of rock, and 510 cords of brush.

Dike A, at Newport, was completed; Dike B, just below Newport, to the extent of building and weighting 306 feet of mattress, and driving a few piles, when high water and the low state of funds rendered the suspension of work necessary. In this reach of river many troublesome snags were also removed. The work has been very effective, and commercial facilities have been greatly increased.

The advance of each season makes it more and more apparent that the vast commerce of the territory drained by this river would before many years demand a lock-and-dam system. The great commercial interests due to the inexhaustible mineral resources of the territory, which are concentrating upon the improvement of this river, are becoming more clamorous for an improved highway, and the possibilities of this river are scarce second to any in the district.

It is very important that my last annual report should be carefully considered, yet I do not think that I am warranted in going over all the ground carefully gone over in that report. I will simply say that the time is coming when a system of locks and dams will be required in the upper river; and it is my duty to renew the recommendation made last year in regard to preliminary surveys in connection with this work.

I must again respectfully invite attention to the increase in the tonnage of the river, and to my statement made in the original plans and estimates submitted several years ago; that in my opinion the time would come when the vast commerce of this territory would demand the application of the lock-and-dam system to this river. And I must again note here as applicable to all my annual reports that while charged with a vast territory, well watered with navigable streams, the people inhabiting the territory are so little conscious of the resources

they possess in their fertile fields, timbered hills, and mineral-stocked mountains and natural waterways, that it is only by the most strenuous efforts that anything like an accurate showing of commerce can be obtained.

I again repeat, also, that the White River has at least all the possibilities of the Tennessee River, with a margin in its favor.

In accord with the above $153,815 are recommended as the amount that can be profitably expended during the fiscal year ending June 30, 1894.

Commerce.—The first appropriation having been made in 1833, the records of this office do not show what was the amount of commerce prior to any attempts at improvements. In the Annual Report of the Chief of Engineers for 1876, page 627, Col. Suter, referring to the upper reaches of this river, says:

> The country bordering on this portion of White River is almost entirely dependent upon water transportation, which, from the difficult character of the navigation, is very uncertain and costly.

And even one year later he speaks of much of the commerce being carried on by teams. (Annual Report Chief of Engineers, 1877, page 501.)

The advantages to commerce if the permanent improvement is effected will be greatest of that to any river in the State in proportion to the cost. This is a natural highway for commerce to an extensive territory, and much of this territory has as yet no other outlet except the wagon. In this connection see Annual Report Chief of Engineers, 1880, page 1313; Annual Report Chief of Engineers, 1884, page 1401; also Annual Report Chief of Engineers, 1885, pages 1589 and 1591. Here will be found a steady increase in commerce, keeping pace with the improvements, which speaks for itself and calls for no comment.

As to benefits to community, it may be said that a community that will follow up the work already done as this one has can but be greatly benefited. Every improvement made is promptly taken advantage of. The rapid growth in prosperity in this section warrants the belief that the permanent improvement of this river will confer benefits upon this community so great that the cost of the works will seem too small for comparison.

Anyone taking the trouble to read the Annual Reports of the Chief of Engineers for the past twelve years will be struck by the uniform testimony of engineers in regard to the future great commerce of this river, a significant fact in itself.

Data gathered from various sources may be condensed as follows:

There is a division in the commerce of this river, the Upper and Lower White, both territories improving rapidly under the present system of river improvements. The Upper White River territory, which needed principally a low-water channel by improvement of shoals to insure a regular transportation of products, is beginning to show a marked improvement in agricultural lands, especially near the river, and yielding a greater tonnage each year. These products, which have been hauled heretofore across the country in wagons from 50 to 80 miles to Springfield and other points on the railroad that lead to St. Louis markets, are beginning to find a more accessible outlet by way of the river to Batesville and Newport, where they are transferred to the railroad and carried to the same market. The ultimate results of this river improvement will not only be a settlement of the country but also a creation of new markets in the direction of New Orleans, to where a cheaper transportation is offered by way of the river. The

mining enterprise is also being engaged in all along the Upper White River, and a greater demand for river navigation is presenting itself to the community in general. During the past year, in developing these mines, several barge loads of zinc ore were shipped down the river at a comparatively low stage of water, the obstructions being so greatly reduced by the river improvement that it was found possible to ship in this way.

A number of enterprising citizens have responded to the inquiry for commercial statistics, of this river, during the past year, and agree that the improvement is of vast importance, to the enhancement of products and settlement of the country. All are high in their praise of the improvements accomplished during the past year, as witnessed by the establishment of a more regular system of freights, the attention given to the opening of mines and quarries of valuable stone, as well as drawing attention to a rich and fertile country that only waits the improvement of the river to be quickly settled by an industrious and enterprising people.

Extract from statement of Mr. George W. Dale is worthy of mention at this point:

State Geologist Dr. John C. Branner is of the opinion that no part of the world can produce finer marbles, or in greater quantities than is found in the counties mentioned.

Mr. Dale says further:

Fifty-five years of practical experience and explorations, twenty-four of which have been devoted mostly to the mountains of Arkansas, convince me that no part of the United States is richer, or scarcely so rich in mineral resources of the kind described as the Upper White River country.

Many thousands of acres of land now considered valueless would be devoted to fruit-growing, towns and cities would line the shore, manufactories and smelting furnaces would be erected, and not only would Arkansas be enriched but the whole country. Within the bounds of the foregoing described district there are innumerable valuable water powers that would be utilized. With Upper White River properly improved all these vast resources would be developed, profitable employment would thereby be given to both capital and labor, and that, too, in a region noted for its healthfulness.

Tonnage of White River, Arkansas.

	Tons.
Upper White River	113,065
Lower White River	38,496
Total	151,561

Matters stated in my last annual report should be read in this connection.

Money statement.

July 1, 1891, balance unexpended	$15,026.41
Received as per letter Chief of Engineers, April 11, 1892	250.00
	15,276.41
June 30, 1892, amount expended during fiscal year	15,190.80
July 1, 1892, balance unexpended	85.61
Amount appropriated by act approved July 13, 1892	75,000.00
Amount available for fiscal year ending June 30, 1893	75,085.61
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	153,815.00

Expense account.

Pay roll	$10,679.03
General supplies	678.32
Subsistence supplies	3,085.23
Lumber	89.64
Fuel	194.68
Traveling expenses	154.06
Stationery	16.38
Transportation	14.55
Medicine	33.20
Piling, brush, and poles	110.15
Stone	106.00
Reserved in United States Treasury for freight charges	29.56
Total	15,190.80

W 6.

IMPROVEMENT OF CACHE RIVER, ARKANSAS.

No change in this report since last year. The $3,000 recommended in the last report not having been appropriated, no work was done on account of lack of funds.

Commerce.—No new data has been secured in regard to commerce since last report, though diligent efforts were used to do so.

Money statement.

Amount appropriated by act approved July 13, 1892	$2,000.00
Amount (estimated) required for completion of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

W 7.

IMPROVEMENT OF LITTLE RED RIVER, ARKANSAS.

The first improvements attempted upon this river were made in the year ending June 30, 1872, under the act approved March 3, 1871.

Prior to this work many overhanging trees interfered with navigation in the lower reaches and many bowlders obstructed flatboat and raft navigation in the reach above the present town of Judsonia. The appropriation referred to above was for the White, Black, and Little Red rivers, and amounted to $10,000 for the three upon estimates amounting to $259,033, of which $38,065 were for the Little Red River. That little work could be done is apparent from Col. Reynolds's report for 1872, in which he states:

> Unless other and better facilities are provided it will be of very little use to attempt to remove the obstructions in such streams as these.

Most of the overhanging trees were removed as high as Judsonia. A bad shoal, 3 miles below Judsonia, and the bowlders remained untouched to the end of June, 1886.

Up to June 30, 1890, $7,153.33 had been expended in removing the

bowlders above Judsonia, in dredging the shoals below Judsonia known as Bess Shoals, care of property and records, constructing the dredge to be used in removing the shoals, and in the construction of two material barges.

During the fiscal year ending June 30, 1891, $2,140.92, including $1,000 of the $3,500 for which the dredge was sold to the appropriation "Improving Arkansas River, Arkansas," was expended on the shoals and cutting overhanging timber above Judsonia.

Previous work having been done for the benefit of rafts principally, which take the channel, while the steamboats take the eddies, much overhanging timber in the eddies which should be cut in the interest of steamboat navigation remaining, and as Bess Shoals had been completed, giving a satisfactory channel and outlet from Judsonia, Ark., to the mouth, on September 3, 1891, a project was prepared in this office and approved by the Chief of Engineers for expending the balance of the available funds, $1,200, in cutting overhanging timber between Judsonia, Ark., and Heber, Ark. This was done to the extent of cutting 11,794 overhanging trees and those threatening the bank of the river and cutting and removing 146 cords of brush.

Bess Shoals were completed early in the year by the removal of 100 tons of broken rock and gravel, making a total of 595 tons removed from these shoals. Expenditure for fiscal year ending June 30, 1892, $1,896.82.

There is now a fair medium-stage channel from the town of Heber, Ark., to Judsonia, and a low-water channel at least 2 feet deep from Judsonia to the mouth.

Commerce.—Amount of commerce when work of improvement began may be inferred from the following, which appeared in the Annual Report of the Chief of Engineers, 1871, page 362:

> The fact stated that the commerce of this stream is sufficient to induce the comparatively large boats running on the White River to navigate it whenever it is practicable, and when this is not the case a small steamer is kept to ply between West Point and the mouth of the river, shows the importance of the interests involved.

As to the further points to be noted, now that the work is completed, I find that two boats have plied the river, one of 76 tons register and the other 36, and that since the improvements they make about 100 trips a year between Judsonia and the mouth of the river. Perhaps the replies to questions sent out will give as clear and condensed an idea of other matters of commerce as any regular form of report. Capt. J. H. Douglass, of Judsonia, Ark., answers the question as follows:

> (3) During what months of the fiscal year ending June 30 was the stream navigable; what was the head of high-water navigation and between what dates; and what was the head of low-water navigation and between what dates? The river was navigable from the 1st of November, 1890, to 1st of August, 1891. Head of high-water navigation, Sugar Loaf Mountain. Have made two successful trips there since the United States Government has made improvements in the river—125 miles farther than any boat has yet ventured up the river. Judsonia the head of low-water navigation the balance of the year.
>
> (4) What benefits have been derived from the work done and what are the prospective advantages to be derived by continuing the improvement? Before the last improvement made by the United States Government successful navigation was impossible even in high water, but since that the navigation has been very good, with but little trouble. By additional work, such as was accomplished under the last appropriation, the river could be made good for the steamboat interest. This is the only outlet for the large and magnificent timber (covering thousands of acres) to a market, and other commercial interests. The produce of a large class of farmers would seek this means of all others of sending their produce to a market. Hundreds of acres of land now in a wild state would soon be made into large and handsome farms if there was a certainty of this river being so improved as to furnish a sure

outlet. Where one bale of cotton is raised to-day three or four would be the result if the river was a sure source of transportation. The only recourse of the farmer at present is by wagon over a rough and hilly country.

(5) General information and remarks. Only one of the two boats were run at a time, the larger one during extreme high water, the smaller one during low-water stage. If additional work, equal to that last done on the river, could be done, the larger boat as well as the smaller one could be used at all times. There is yet much overhanging timber very troublesome, and in Horseshoe Bend, about 70 miles above Judsonia by river, some very troublesome stumps. These were cut last season during high water, and are now much in the way at a medium stage.

I was captain and engineer of the *A. Saltzman* ever since she came into the river, some eighteen months ago, and held the same positions on the *Little Red* since she was built.

Money statement.

July 1, 1891, balance unexpended	$1,896.94
Received, as per letter Chief of Engineers April 11, 1892	300.00
	2,196.94
June 30, 1892, amount expended during fiscal year	1,896.82
July 1, 1892, balance unexpended	300.12
July 1, 1892, outstanding liabilities	133.00
July 1, 1892, balance available	167.12

Expense account.

Pay roll	$1,468.50
General supplies	139.91
Subsistence supplies	181.36
Lumber	22.51
Traveling expenses	39.06
Stationery	5.20
Rent	40.00
Total	1,896.54
Deposited to credit of United States Treasury	.28
Grand total	1,896.82

W 8.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river the magnificent timber which lines its banks overhung its narrow and deep channel, giants of the forest stretched across it from bank to bank in falling, débris from logging camps lodged in the same, producing shoals, all of which presented a formidable array of obstacles not only to navigation, but to any attempts at improving the same. The original plan for its improvement contemplated the removal of the obstructions, and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed, so as to confine the water to the main channel. The work has been steadily carried forward, with very small appropriations, at irregular intervals, for upwards of fourteen years. In the earlier operations the appliances were not adapted to the heavy work on hand. In later years, suitable appliances having been secured, more rapid progress has been made. Its channel being narrow, water deep, and banks firm, it is one of the most satisfactory streams in this district to improve.

Up to June 30, 1891, $62,779.68 had been expended in carrying out the above plan, giving a very good river from the mouth up to the mouth of Current River, doing but little for the reach between the mouth of Current River and the bridge at Corning, Ark., and making a visible impression upon the formidable obstructions between the Arkansas State line and Poplar Bluff, Mo., in conjunction with the appropriation under the heading "Improving Black River, Missouri."

During the fiscal year ending June 30, 1891, only $1,537.28 was expended in necessary repairs to the plant and care of property. As stated in my last annual report, the boat built for the Cache River was transferred to this stream by proper authority, and work begun at Poplar Bluff, Mo., under appropriation "Improving Black River, Missouri," with a view of working down to the Arkansas State line on that appropriation, and then beginning work under this head. About the time the work had reached the State line and the boat had been transferred to this appropriation the river rose, and from that time to the end of the fiscal year remained too high for effective snagging operations. During the fiscal year ending June 30, 1892, $3,181.76 was expended. On July 25 the boat was put into the field and operated from Corning, Ark., to the mouth of Current River, thence back to the Arkansas and Missouri State line, in order to have the boat available for operations on "Black River, Missouri, appropriation."

On this reach of river, a distance of about 90 miles, 1,755 snags and 166 masses of driftwood were removed and 24,622 trees cut, making effective work and clearing the river of obstructions. The deserving character of this stream, on account of its deep water and permanent banks, the magnificent territory drained by the river, rich in the finest agricultural lands and splendid timber, a country susceptible practically of unlimited development and settling up with a good class of people, combined, call aloud for due attention to their commercial interests.

It would seem like a redundancy to reiterate facts that have so often appeared in my annual reports in regard to the great benefits to be conferred by the opening of this river and to the deserving character of the stream, on account of its deep water and permanent banks, yet, as I come to know this stream more and more thoroughly from year to year, I am more convinced that the recommendations made in the past should not only be renewed, but emphasized in their renewal. My plan has been to secure an annual contingent of $8,000 for this work, but this has been departed from so far in the amounts of the appropriations, that nothing less than $42,000 would adequately meet the requirements of the situation. It may be stated that with the expenditure of this sum as a whole a magnificent artery of commerce would be effectively opened, which would need but very little attention for its maintenance.

Commerce.—No new data has been received in regard to commerce since last report, though diligent efforts were used to do so.

Money statement.

July 1, 1891, balance unexpended	$3,462.72
June 30, 1892, amount expended during fiscal year	3,181.76
July 1, 1892, balance unexpended	280.96
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	5,280.96
Amount (estimated) required for completion of existing project annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	42,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay roll	$2,463.59
General supplies	81.32
Subsistence supplies	464.97
Lumber	4.89
Rent	40.00
Traveling expenses	84.63
Transportation	14.75
Medicine	7.27
Reserved in United States Treasury for freight charges	20.34
Total	3,181.76

W 9.

IMPROVEMENT OF BLACK RIVER, MISSOURI.

The first improvements attempted upon this reach of river were made in the years 1881 and 1882.

Prior to this work its channel was choked with logs and snags and obstructed by overhanging trees, and in many places shoals interfered with its navigation at low water by any but very light-draft boats. Its banks caved but little, and except at the shoals it is characterized by greater depth of water than is found in streams generally in its vicinity, due to its being narrow and its banks firm. The original plan for its improvement contemplated the removal of the obstructions and the improvement of the shoals, the latter by wing dams. A few sloughs were to be closed up, so as to confine the water to the main channel.

Up to June 30, 1891, $16,675.71 had been expended in carrying out the above improvement, as follows:

Up to June 30, 1888, $6,000 had been expended, which had opened up about 20 miles from Poplar Bluff, Mo., toward the mouth. Owing to the difficulty of getting suitable appliances up to this reach, it was carried on with great difficulties.

During the fiscal year ending June 30, 1889, the snag boat *Henry Sheldon*, specially constructed for work on this river, was successfully pushed through to Poplar Bluff, and operated from there down the river, rapidly and effectively clearing the same of obstructions. Six thousand five hundred and sixty dollars and thirty cents were expended in the work, erecting a strong dam at the head of Dan River (a chute of the Black River), removing 293 snags, cutting 1,874 overhanging trees, deadening 17,490 trees, and removing 12 masses of drift wood, carrying the work to the Arkansas State line, removing the greater portion of the dangerous low-water snags, and making a good beginning upon the overhanging timber.

During the fiscal year ending June 30, 1890, only $199.20 was available, and this was expended, in connection with the other appropriation for this river, in the running expenses of the snag boat *Henry Sheldon*.

During the fiscal year ending June 30, 1891, $3,914.21 were expended between Poplar Bluff, Mo., and the Arkansas State line, removing 406 snags, destroying 23 piles of drift, and cutting 10,450 overhanging trees; high water preventing further work.

During the fiscal year ending June 30, 1892, $2,990.20 were expended. The boat commenced operations at the Arkansas State line November 1, immediately after completion of work "Improving Black River, Ar-

kansas and Missouri." From about December 10 to the 23d of the same month the water was too high for effective snagging operations, and the boat was laid up in ordinary on that day at Poplar Bluff, Mo., on account of high water and the low state of the funds.

During this period, from November 1 to December 23, 391 snags were removed; 8,474 overhanging trees cut. For the same reasons given above no attempt was made to do any work on the dam at the head of Dan River. The stream has been greatly improved in this reach, and good progress made toward a thorough opening of the river. There is still overhanging timber that should be removed, and many snags and logs, and the dam at the head of Dan River should be strongly rebuilt. Much difficulty has been experienced by loggers floating their logs loose and not rafting them, which by lodging cause obstructions to navigation. It seems to me that there should be a penalty fixed for creating an obstruction in this way nearly, if not equally, as great as that where a bridge is an obstruction to navigation. More intimate knowledge of the river in this reach leads me to confirm all that I have said in regard to its being worthy of improvement, and to add a considerable more in the way of emphasizing the same.

To economize space, everything that needs to be said in regard to future work has been placed under the general heading "Improving Black River, Arkansas and Missouri," as that covers the same ground.

Commerce.—See report "Improving Black River, Arkansas and Missouri.

Money statement.

July 1, 1891, balance unexpended	$3,085.79
June 30, 1892, amount expended during fiscal year	2,990.20
July 1, 1892, balance unexpended	95.59
July 1, 1892, outstanding liabilities	75.00
July 1, 1892, balance available	20.59
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1894	(*)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay roll	$2,189.20
General supplies	156.19
Subsistence supplies	264.37
Stationery	11.20
Typewriter	95.00
Rent	40.00
Traveling expenses	229.64
Transportation	3.75
Medicine	.85
Total	2,990.20

* See report for "improving Black River, Arkansas and Missouri."

W 10.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Earliest appropriations made for this river under any head were made by act approved March 2, 1833.

Summing up all the various works of improvement, it may be inferred that prior to 1833, this river was much choked with drift piles, logs, and snags, its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs.

This river has been united so often with the White River and also with the Black River, that it is impossible to give exactly how much had been expended upon the St. Francis River to June 30, 1884. From June 30, 1884, to June 30, 1890, $24,000 were appropriated; $12,000 in 1884, $8,000 in 1886, and $4,000 in 1888, and this had been practically expended. The history of its expenditure is the history of all work in new countries with entirely inadequate appropriations made over long reaches of river. Most constant and careful study has been given to making the money do as much work as possible. The snag boat *Johnson* was first designed for this river, and its light draft, great power, and light running expenses were first utilized on this river. A vast amount of very hard pioneer work has been done. Once or twice sickness in the swamps has demoralized the crew. Diverse interests have opposed the boat's progress here and there, but with steady persistence the work has been carried on, looking to the ultimate opening of the river as contemplated in the original project. The little reach above the Sunk Lands has been well opened and greatly to the advantage of commerce. The transfer of the boat has caused great delay. This has been obviated by building a separate twin boat partly out of the appropriation to operate above the Sunk Lands in conjunction with the appropriation "Improving St. Francis River, Missouri."

Up to June 30, 1891, $26,499.10 had been expended as individual or distinct appropriations for this river. During the fiscal year ending June 30, 1892, $1,457.76 was expended. Early in July the boat was put into the field, and effective operations carried on from the cut-off to the town of Madison, Ark., a reach of river about 25 miles in length and badly in need of work, 205 snags were removed, and several drift piles destroyed. This work was between July 4 and August 15, 1891, when the low state of the funds made it necessary to stop operations, and the boat was taken to her new field of operations on Little River, Missouri, to which she had been temporarily transferred by proper authority.

It is scarcely proper to include in this report anything that is a reiteration of the reports of former years, yet in order to obtain the information necessary to a thorough understanding of the merits of the river, its commerce, the amount of water in its channel, the difficulties under which it is worked, it is absolutely necessary that the reports for the last six years be carefully gone over. The more study I have given the stream and the country, the more interesting the study becomes and the more convincing are the arguments in favor of opening up the river. With no transportation except the wagon, a fertile section rapidly settling up between Lesters Landing and St. Francis would at once pour out through this channel its products, adding many times the sum required for the improvements to the material prosperity of the country.

Whatever decision may be rendered as to the desirability of further

expenditure, the river now has a plant of its own, peculiarly adapted to its work and can be cared for at a very small outlay. It would be better to put the river in excellent shape before the plant deteriorates, and it is believed that after a few years of thorough work the river will maintain itself. As to future demands, the development of the country can alone decide what these will be. It may be that dredging the Sunk Lands to bring the river back to its own channel may be warranted in years to come and that low-water navigation may be demanded. At present the prospect is too remote to devote time to plans and estimates for these improvements. The plan recommended for several years, that $8,000 be appropriated annually, not having been carried out, the river is fully $28,000 behind in needed improvements, and that sum could be profitably expended in the fiscal year ending June 30, 1894. The work is being carried on systematically and effectively, but there is yet much to be done. Nowhere in the State will the results be any more direct, nor is there any section where the amount necessary to improve the stream is any smaller in proportion to the benefit to be conferred.

Commerce.—No new data in regard to commerce has been received since last report, although diligent efforts have been made to do so.

Money statement.

July 1, 1891, balance unexpended	$1,500.90
June 30, 1892, amount expended during fiscal year	1,457.76
July 1, 1892, balance unexpended	43.14
Amount appropriated by act approved July 13, 1892	8,000.00
Amnunt available for fiscal year ending June 30, 1893	8,043.14
Amount (estimated) required for completion of existing project, annually	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	28,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Expense account.

Pay roll	$873.14
General supplies	47.93
Subsistence supplies	236.74
Boiler	206.00
Traveling expenses	34.75
Medicine	1.44
Transportation	23.55
Skiff and oars	20.00
Voucher chest	5.00
Stationery	3.15
Deposited to credit of United States Treasury	6.06
Total	1,457.76

W 11.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

The first appropriation made for this work was that of $5,000 by act of August 11, 1888. Prior to this time the river channel was choked with logs and snags, overhanging trees interfered with the smokestacks,

and several shoals interfered with low-water navigation. The original project contemplated the removal of the shoals 12 miles below Greenville, Mo., the removal by a snag boat of stumps, snags and overhanging trees from Greenville, Mo., to the town of St. Francis, Ark. Up to June 30, 1890, $5,000 had been expended opening up very thoroughly the river from Greenville, Mo., to a point about 80 miles above St. Francis, Ark. A few obstructions were removed over this latter reach.

By act approved September 19, 1890, $10,500 were appropriated to carry on the work. As much trouble had been experienced in getting the snag boat *A. B. Johnson* through the Sunk Lands, this being a barrier impassable except at extreme high water, and being a natural division of the river into its districts, rather than the arbitrary one at St. Francis, Ark., proper authority was secured to build a snag boat, the duplicate of the *Johnson*, to operate above the Sunk Lands altogether, leaving the *Johnson* for the work below and also for the work in Little River. During the fiscal year ending June 30, 1891, this boat was built and equipped. From the time the boat was completed to the close of the fiscal year the water was too high for effective operations. Early in September of the present fiscal year, the water having reached a proper working stage, the boat was started out. Commencing operations at the town of St. Francis, she worked through to the Big Drift, a distance of about 70 miles, at which point high water and cold weather caused operations to cease, the boat was returned to St. Francis and laid up in ordinary. One thousand four hundred and twenty-three snags were removed, 5,405 overhanging trees cut, and 15 piles of drift that had accumulated against snag obstructions, dilodged.

During the fiscal year ending June 30, 1892, $4,687.09 was expended. As before stated, operations stopped at the Big Drift, consequently the shoals 12 miles below Greenville were not reached. In the near future this reach of river will require careful attention; the territory is a rich and fertile one, and some judicious effort to overcome these shoals in the interest of low-water navigation will be a demand in the interest of the increased commerce.

The claim supposed to be presented by the Dunklin County Transportation Company for a cut-off owned by them and for which the act provides payment, has not yet been presented and, as stated in a former report, it is doubtful if it ever will be. Two thousand dollars, however, has been reserved to meet this, if ever presented. This money will eventually be applied either to improve the cut-off or the old river, as may seem most expedient. The increase in commerce in the upper river warrants an expenditure of additional money between St. Francis and Greenville. According to law, however, I apprehend that any estimates would not be in order in this report, as it would be new work.

Commerce.—For commerce see "Improving St. Francis River, Arkansas."

Money statement.

July 1, 1891, balance unexpended	$7,857.32
June 30, 1892, amount expended during fiscal year	4,687.09
July 1, 1892, balance unexpended	3,170.23
July 1, 1892, outstanding liabilities	193.35
July 1, 1892, balance available	2,976.88

Expense account.

Pay roll	$3,166.18
General supplies	732.71
Subsistence supplies	464.82
Fuel	5.05
Stationery	22.50
Traveling expenses	115.68
Grab hooks	20.00
Medicine	7.36
Transportation	.75
Oars	1.44
Total	4,536.49
Reserved in United States Treasury for freight charges	150.60
Grand total	4,687.09

W 12.

IMPROVEMENT OF LITTLE RIVER, MISSOURI.

The first appropriation ever made for this river was that of the act which became a law August 11, 1888, amounting to $5,000 (five-eighths of the estimate, $8,000). The project for improvement contemplates rendering it navigable at high and medium stages from Hornersville to its junction with the St. Francis River, especially to prolong the medium stage of water by confining the water to one of the two chutes making out of the lake upon which Hornersville is situated, and by removing the snags, logs, and masses of driftwood that have accumulated in the channel. The project for the expenditure of the $5,000 referred to above provides that it be expended as follows, viz: $1,500, or as much as may be necessary, in building a dam across one of the chutes at or near the lake, and the balance in removing the worst obstructions, in the way of overhanging trees, logs, snags, and drift, over the distance specified, and that the snag boat *A. B. Johnson* be used for this work, being transferred in due form and by proper authority and at the proper time for this purpose, the dam to be constructed of brush and gravel, brush and rocks, or of such other material as may be had in the locality as may be best adapted to the purpose, the work to be executed by hired labor and the purchase of material in open market, as this is most economical and advantageous to the Government. It will be seen that this provides for the use of the snag boat *A. B. Johnson.*

There was expended during the fiscal year ending June 30, 1891, $2,865.69 in removing snags, drift piles, and cutting overhanging trees to a point 80 miles from the mouth known as Perkins Bar, and constructing a dam 300 feet long across the right chute.

By act approved September 19, 1890, $3,000 was appropriated. On November 22, 1890, the water continuing low and the boat being required for work upon the appropriation to which she properly belongs, she was withdrawn from the river.

For the fiscal year ending June 30, 1892, $3,011.38 was expended. Early in the year an attempt was made to resume operations, but had to be abandoned on account of low water until late in the month of December, at which time the boat was dispatched to the point where work was stopped the previous year; from there she worked her way through to the lake, a distance of about 40 miles. Ninety-six snags

were removed, 1,087 overhanging trees cut, and 8 driftpiles dislodged. Extreme cold weather overtook the working party before their arrival and high water met them at the lake; they were therefore compelled to stop operations, aside from the collection of some material for use in repairs to the dam. The boat was taken to Marked Tree, Ark., near the mouth of the river and laid up. The work done on this river has already afforded much relief to the territory drained, and those interested have not been slow to take advantage of and utilize the channel as opened. The obstructions were more formidable than the reconnoissance showed, and to carry out the original project about $3,000 additional will be required.

The commerce fully warrants the outlay, and it is accordingly recommended.

Commerce.—No new data having been received in regard to commerce, it is not thought advisable to take up space in this report to simply reiterate the remarks of last year, as these are already a matter of printed record and may be referred to if necessary.

Money statement.

July 1, 1891, balance unexpended	$3,031.90
June 30, 1892, amount expended during fiscal year	3,011.38
July 1, 1892, balance unexpended	20.52

Expense account.

Pay roll	$1,717.83
General supplies	225.79
Subsistence supplies	555.33
Medicine	16.66
Traveling expenses	37.65
Fuel	405.35
Transportation	19.69
Deposited to the credit of United States Treasury	4.44
Reserved in United States Treasury for freight charges	28.64
Total	3,011.38

W 13.

PRELIMINARY EXAMINATION AND SURVEY AT CLARENDON AND THE LOWER WHITE RIVER, ARKANSAS, TO DETERMINE THE EFFECT OF BACKWATER FROM THE MISSISSIPPI RIVER AND ITS CAUSE, AND THE MEANS AND COST OF PREVENTING INJURY THEREFROM.

[Printed in House Ex. Docs. Nos. 118 and 163, Fifty-second Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 1, 1892.

SIR: I have the honor to submit herewith copies of reports, dated December 2, 1890, and January 18, 1892, respectively, upon preliminary examination and survey of "Clarendon and the Lower White River, Arkansas, to determine the effect of backwater from the Mississippi River and its cause, and the means and cost of preventing injury therefrom,"

made by Capt. H. S. Taber, Corps of Engineers, in compliance with provisions of river and harbor act approved September 19, 1890.

Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, reports that the construction of levees along the Mississippi River below Helena, Ark., will prevent, as far as is practicable, injurious effects of the Mississippi River backwater on the White River.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. S. B. ELKINS,
Secretary of War.

PRELIMINARY EXAMINATION AT CLARENDON AND THE LOWER WHITE RIVER, ARKANSAS, TO DETERMINE THE EFFECT OF BACKWATER FROM THE MISSISSIPPI RIVER AND ITS CAUSE, AND THE MEANS AND COST OF PREVENTING INJURY THEREFROM.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., December 2, 1890.

GENERAL: In accordance with the requirements of a letter dated Office Chief of Engineers, Washington, D. C., September 20, 1890, I have the honor to report that the preliminary examinations called for therein have been made. * * *

The situation at Clarendon can only be determined by a most careful study. Have visited the locality in person. Have had gauges, such as I have, plotted carefully, and a careful reconnoissance has been made of the vicinity by a competent assistant engineer, and there are not data enough to settle the question as to the influence of the backwater from the Mississippi River. In the first place a study of the gauges indicates errors in the record or observation as the plotted gauges show impossible anomalies. This is a serious matter, since by them the question must in part be solved as follows: With a height of crest of flood wave at Jacksonport or Newport, and a given height of crest of flood wave in the Mississippi River at mouth of White River, there will be a certain resultant height at Clarendon if the backwater of Mississippi River affects this gauge.

Throwing out the small tributaries, the same reading of gauge at Jacksonport should give the same reading of gauge at Clarendon, or practically so; if that gauge is unaffected by the Mississippi River backwater, etc., clearly then accurate gauges are very important. Next, an accurate line of levels extends from Helena to the mouth of White River upon the Mississippi River, and another accurate line extends up White River to Clarendon. These show that with extreme low water in the White and extreme high water in the Mississippi, a very improbable combination, the water of the Mississippi would not back up the White River nearer than 50 miles of Clarendon. Reliable information shows that the Mississippi River flood goes over bank below Helena (see blue print*), proceeds across the country, presenting a wall of water to the flood of the White River. Just the height of this wall, just where it extends, is of vast importance in the solution of these questions, and these data can only be had by a careful instru-

* Not printed.

mental survey with an accurate line of levels sufficiently widely extended to give an idea of where the waters of the White meet those of the Mississippi in the mutual overflow. What precedes indicates that gauge reading and survey will be necessary.

The gauge-reading should extend over at least one year and will require to observe one at Jacksonport and the other at Clarendon. This is probably all the time that can be spared, and may give data with which to correct the more extended observations. A longer period would be more satisfactory. The survey will require about a month's work. The cost will be about as follows, viz: For the gauges:

Two observers, at $35 per month, each, for one year	$840
Stationery and incidentals	60
	900

Survey (transalluvial) from Old Town to St. Charles, and other surveys for the purpose of determining the topography of the vicinity.

One assistant engineer in charge, at	$150
One assistant engineer (transitman)	100
One assistant engineer (leveler)	100
Two chainmen, at $40	80
One rodman, at $40	40
Four axmen, at $25 each	100
One flagman, at $60	30
	600
One cook	40
One team and teamster	75
	715
Two tents and flies, 14 by 16, $35	70
Twenty-four pair blankets	80
Camp equipage, cooking stove	50
One month's provisions	125
	1,040
Instruments on hand, T. and L	275
Stationery on hand	10
	1,325
Gauge observers	900
Contingencies	275
Total	2,500

I have the honor therefore to respectfully recommend that the gauges be kept and the survey made at the above cost, as the interests involved fully warrant such an outlay; and again, the value to both the White and Mississippi River improvement works of the information gained would fully warrant it, aside from any purely local interests. The accompanying hydrographs* will explain themselves.

The present commerce is 24,379 tons at this locality and is steadily increasing, keeping pace with the general tendency of increase throughout the State.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

* Not printed.

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
Little Rock, Ark., December 27, 1890.

Respectfully returned to the Chief of Engineers (through the Division Engineer).

* * * * * * *

In my opinion * * * the locality is worthy of improvement.

* * * * * * *

H. S. TABER,
Captain, Corps of Engineers.

[Fifth indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 30, 1890.

Respectfully returned to the Chief of Engineers.

* * * * * * *

I am of opinion that the lower White River from Clarendon down is worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A., Division Engineer.

SURVEY AT CLARENDON AND THE LOWER WHITE RIVER, ARKANSAS, TO DETERMINE THE EFFECT OF BACKWATER FROM THE MISSISSIPPI RIVER AND ITS CAUSE, AND THE MEANS AND COST OF PREVENTING INJURY THEREFROM.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 18, 1892.

GENERAL: In accordance with the requirements of letters dated Office Chief of Engineers, U. S. Army, Washington, D. C., September 20, 1890, and January 2, 1891, I have the honor to submit the following report respecting the survey at Clarendon and the lower White River, with a view to determining the effect of backwater from the Mississippi River and its cause, and the means and cost of preventing injury therefrom. In the provisions of the first-mentioned letter, I, in company with an assistant, visited the locality and established a number of facts; and in establishing these facts, certain questions arose for settlement, which could only be settled by a survey. The facts may be briefly summarized as follows:

(1) Until quite recently, the town of Clarendon has been entirely above overflow, or nearly so.

(2) That of late years it has been overflowed, or portions of it, to a depth of over 2 feet, seriously interfering with business, causing great apprehension on the part of the inhabitants, great deterioration in value of property, threatening the commercial interests representing nearly 25,000 tons of freight annually, which is received and delivered at this point; to which may be added a third apparent fact, this overflow has

occurred since the giving way of the levees below Helena, on the Mississippi River between Helena and the mouth of the White River.

The questions that arose were:

(1) How near does high water in the Mississippi River back up the White River towards Clarendon; *i. e.*, how far it would do so if it simply came in at the mouth of the White River?

(2) How much water comes across the country between Helena and the mouth of the White River and what effect, if any, would this have upon the backing up of the waters of the White River and increasing the flood at Clarendon?

(3) If the levees were all in repair from Helena to the mouth of the White River, would the height of the flood at Clarendon be reduced to the old-time limit?

Having a survey of the Mississippi and of the White River, the first question was readily answered, *i. e.*, in a theoretical way. Practically it would not be possible to eliminate the water coming across the country from the Mississippi; but, supposing that any such water could come across the country, and the White River be at extreme low water and the Mississippi at extreme high water, the water of the Mississippi would flow back up the White River to within 50 miles of Clarendon. It was apparent that the other questions could only be answered by running a number of lines of levels and to thoroughly investigate the whole matter.

It was estimated in my letter of December 2, 1890, that $2,500 would be expended in gauge observations and in a survey. The letter referred to herein from your office, dated January 2, 1891, informs me that the amount available for each locality for survey, in the river and harbor act approved September 19, 1890, really should not exceed $500, but that $1,000 was allotted for the above work. Accordingly I waited until the leaves were off the trees and the water was low, and, equipping a party as cheaply as possible, succeeded in running one line of levels from St. Charles to Old Town, as indicated on the tracing sent herewith. This does not give as much data as ought to be had in regard to the question, but settles one point, however, and that is, that water making in at Helena and below would flow across the country and strike the White River channel at about a point 50 miles below Clarendon, where the water backing up from the mouth of White River would extend. It does not enable me to say definitely what volume of water will meet this from other points below, nor can as good an idea as was desirable be formed of the height of the wall of waters proceeding across the country, as there are numerous ridges that will undoubtedly cut off some.

There are several hydrographs* submitted herewith of the White River and the Mississippi. These show that the marked rises at Clarendon are apparently effected by the rises near the headwaters of the White River. The problem is too delicate to be solved without more data. Different opinions might prevail as to the effect of this water, but with the data secured already in hand I do not see anything to warrant any very positive declarations one way or the other. With the repairs that are now going on, or have been going on, at the levees below Helena, it is possible that a practical solution of the problem may be had very soon by conditions being made the same in the Mississippi River as they were several years ago, and if this condition is likely to be met within the ensuing year, I should be in favor of letting

*Not printed.

the whole matter rest where it is until the levees were so repaired. If it is not deemed advisable to wait for this practical solution, then I feel that the only thing to be done is to continue the survey and secure the necessary data. I believe, from the study given the matter and conversations had with citizens, that if the levees are all put in good condition below Helena, on the Arkansas side, that this will put an end to the difficulty.

Even with additional expenditure for survey it is by no means certain that even then anything like an accurate estimate could be given of the effect of the Mississippi River on the White River at Clarendon. It is a well-known fact that rivers having no greater fall to the mile than the White River are affected many miles up to an appreciable degree by the floods of the rivers into which they flow, and there is no doubt but that with the Mississippi River low and a flood in the White River (an unusual combination) the White River would empty itself much more rapidly than when the Mississippi River is up; but to show graphically or demonstrate accurately that the waters of the Mississippi would affect the White River so many feet is not an easy problem.

The situation at Clarendon is serious, and the amount of commerce, amounting to about 25,000 tons of merchandise, warrants the careful consideration of this entire matter; and any outlay to secure further data would be of no loss to the country generally, whether it effected anything for Clarendon or not, because it will give data in regard to the country lying between the Mississippi River and the White River that will be very useful in the future projects for the improvement of the two rivers, and worth all that it costs to secure data of these two rivers, to say nothing about the town of Clarendon. I would recommend, therefore, one of two things: That all further consideration of the matter be suspended until the effects of completing the levees below Helena can be seen; or else, that a further allotment of $1,500 be made to complete the levels necessary for a thorough study of the matter.

I am, sir, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

POSTSCRIPT.—The tracings * sent herewith speak for themselves of the study that has been given this matter, and render unnecessary any elaboration in the way of a memoir.

The device for showing the combined effects of the waters of the two rivers is very largely due to Mr. J. R. Van Frank, my assistant engineer.

Lest I should not have made myself plain, I add here that it is my opinion that the Mississippi water does affect the height of the water at Clarendon. How much it affects it, however, is a problem that remains unsolved.

H. S. T.

* Not printed.

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 29, 1892.

Respectfully forwarded to the Chief of Engineers.

As the perfect leveeing of the Mississippi River below Helena will present injurious effects of Mississippi backwater on the White River, as far as is practicable, further surveys in the vicinity of the White River are not deemed necessary.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A., Division Engineer.

REPORTS SUBMITTED IN COMPLIANCE WITH RESOLUTION OF HOUSE OF REPRESENTATIVES OF MARCH 4, 1892.

[Printed in House Ex. Doc. No. 163, Fifty-second Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 9, 1892.

SIR: I have the honor to acknowledge the reference to this office of resolution of the United States House of Representatives of the 4th instant, as follows:

Resolved, That the Secretary of War be, and he is hereby, requested to furnish the House of Representatives, at the earliest day practicable, such information as he may have in regard to the effect of backwater from the Mississippi River and its cause, and the means and cost of preventing injury therefrom, at Clarendon and the Lower White River, Arkansas, as directed in the "act making appropriations for the improvements of rivers and harbors, and for other purposes," approved September 19, 1890.

In reply thereto I beg to invite attention to the report by this office, under date of February 1, 1892, on the examination and survey of Clarendon and Lower White River, Arkansas, made by Capt. H. S. Taber, Corps of Engineers, to comply with a requirement of the river and harbor act of September 19, 1890, and published as House Ex. Doc. No. 118, present session of Congress, a copy of which is herewith. In the report referred to the opinion is expressed by Col. C. B. Comstock, Corps of Engineers, the division engineer, that the construction of levees along the Mississippi River below Helena, Ark., will prevent, as far as practicable, injurious effects of Mississippi River backwater on the White River.

Accordingly, with the view to obtaining the further information called for by the resolution under consideration, Colonel Comstock was directed to furnish an estimate of the cost of constructing these levees. This estimate he submitted in report of the 7th instant, a copy of which is herewith.

Col. Comstock states that only an approximate estimate of the cost can be given on account of the uncertainty as to the increase in flood heights which will arise from confining floods to the main river. He gives the approximate estimate of the cost of constructing sufficient levees along the Mississippi River from Helena to the White River, as follows: 5,100,000 cubic yards of levee, at 22 cents per cubic yard, $1,100,000. I concur in the views of Col. Comstock, and beg to say

that the reports herein referred to and accompanying this letter contain all the information in this office regarding the subject-matter of the resolution.

The resolution is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. S. B. ELKINS,
Secretary of War.

REPORT OF COL. C. B. COMSTOCK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
New York City, March 7, 1892.

GENERAL: In reply to your letter of March 5, 1892, I have the honor to state that only an approximate estimate of the cost of sufficient levees along the Mississippi River from Helena to the White River can be given on account of the uncertainty as to the increase in flood heights which will arise from confining floods to the main river.

An approximate estimate is 5,100,000 cubic yards of levee at 22 cents, $1,100,000.

The annual cost of maintenance of these levees would be small if they were everywhere so far back from the river as to be safe from caving for fifty years, probably not more than 1 or 2 per cent.

If built near caving bends this cost of maintenance will be largely increased, by what amount can not be foreseen, as it depends on the unknown changes which may occur in the position and form of the river, and which may cause levees to cave into it.

Very respectfully, your obedient servant,

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX X.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND ILLINOIS RIVERS, OF HARBOR AT ST. LOUIS, OF OSAGE AND GASCONADE RIVERS, MISSOURI, AND OF KASKASKIA RIVER, ILLINOIS.

REPORT OF MAJOR A. M. MILLER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between the Ohio and Illinois rivers.
3. Harbor at St. Louis, Missouri.
4. Gasconade River, Missouri.
5. Osage River, Missouri.
6. Kaskaskia River, Illinois.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 9, 1892.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year ending June 30, 1892, for the works in my charge.

Very respectfully, your obedient servant,

A. M. MILLER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

X 1.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

The work for the fiscal year consisted in the removal of snags, logs, and leaning trees between the mouth of the Missouri River and Natchez, Miss.

The river was divided into two districts, the first extending from the mouth of the Missouri River to Memphis, Tenn., and the second from Memphis, Tenn., to Natchez, Miss. The snag boat *H. G. Wright* was assigned to work in the first district, and the snag boat *J. N. Macomb* to the second district.

The *Wright* began work on August 1, 1891, and worked continuously until February 29, 1892; the *Macomb* began work on August 15, 1891, and remained in commission until March 15, 1892.

The work accomplished by the snag boats is given in the following table:

Name of snag boat.	Snags pulled.	Trees cut.	Drift piles removed.	Miles run.
H. G. Wright	1,633	11,532	20	5,860
J. N. Macomb	1,756	9,039	10	7,183
Total	3,389	20,571	30	13,043

The boilers ordered for the *Macomb* during the previous fiscal year were received and placed in position on the boat; a new butting beam was also placed on the *Macomb*. Other repairs were made to both boats and they are now ready to be put in commission as soon as the needs of commerce may require.

The work accomplished by the snag boats is of great benefit to the navigation of the river, formerly the wrecking of steamboats by running on snags was of frequent occurrence, but since the snag boats have been at work it is almost unheard of.

An annual appropriation having been made for this work of an amount not to exceed $100,000, the snag boats will be put in commission and will patrol the river whenever necessary, and will keep the channel clear of obstructions.

The amount expended on this work during the fiscal year ending June 30, 1892, was $98,250. A detailed statement of the expenditures is given in the accompanying tables Nos. 1 and 2:

Money statement.

Amount drawn under section 7, act of August 11, 1888	$98,250.00
June 30, 1892, amount expended during fiscal year	98,250.00
July 1, 1892, amount available for fiscal year 1892–'93	100,000.00

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River during fiscal year 1892, as required by section 7 of the river and harbor act of August 11, 1888.*

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
First	1	Hired men	Services	$1,390.52
	2	do	do	1,269.80
	3	Sundry persons	Subsistence stores	214.50
	4	Ewald Iron Co	Supplies	42.40
	5	J. D. Lawnin	Repairing cabins	576.00
	6	N. O. Nelson Manufacturing Co	Outfit	82.50
	7	Fulton Iron Works	Castings	11.99
	8	Anchor Line Store	Supplies	6.15
	9	David Nicholson	Subsistence, etc	443.54
	10	St. Louis Refrigerator and Wooden Gutter Co	Lumber	12.80
	11	John J. Ganahl Lumber Co	do	265.78
	12	Charles Miller	Smokestack	36.48
	13	St. Louis, Iron Mountain & Southern Rwy. Co	Commutation ticket	12.25
	14	James Rees	Boilers	8,200.00
	15	J. Kennard & Sons Carpet Co	Linoleum	50.70
	16	Hired men	Services	603.00

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
First ...	17	Hired men	Services	$1,499.36
	18	......do	......do	1,379.66
	19	Sundry persons	Subsistence stores	39.38
	20	J. D. Lawnin	Repairs and lumber	343.08
	21	W. J. Johnston	Plumbing, etc	109.69
	22	St. Louis Refrigerator and Wooden Gutter Co	Lumber	179.79
	23	N. O. Nelson Manufacturing Co	Outfit, etc	255.45
	24	The W. A. Bonsack Lumber Co	Lumber	111.87
	25	Anchor Line Store	Outfit and supplies	184.18
	26	Commercial Printing Co	Stationery	12.75
	27	Buxton & Skinner Stationery Co	......do	22.87
	28	Huse & Loomis Ice and Transportation Co	Ice	64.95
	29	Gust. Bischoff	Subsistence	562.52
	30	Simmons Hardware Co	Outfit	1.70
	31	Ewald Iron Co	Iron	22.14
	32	Van Nort Bros	Putting up electric-light plant.	399.05
	33	Broderick & Bascom Rope Co	Supplies	2.66
	34	G. E. Meissner	Subsistence	10.40
	35	Pat. Norton	Brick work	31.50
	36	Francis Whittaker & Sons	Salt meats, etc	368.30
	37	Chris. Sharp Commission Co	Subsistence	5.00
	38	Scharff, Bernheimer & Co	......do	538.54
	39	Goddard-Peck Grocer Co	......do	147.66
	40	Greeley-Burnham Grocer Co	......do	159.57
	41	Ezra H. Linley	Steel	21.52
	42	Medart Patent Pulley Co	Pulleys	11.45
	43	Peterson & Homes	Outfit	35.40
	44	J. D. Street & Co	Supplies	12.70
	45	Chas. W. Barstow	Paints and oils	65.53
	46	Western Coal & Tow Co	Coal, etc	321.25
	47	The W. A. Bonsack Lumber Co	Lumber	98.35
	48	Page & Tolkacz	Outfit and repairs	325.30
	49	St. Louis post-office	Postage stamps	3.50
	50	Paddock-Hawley Iron Co	Iron, etc	100.83
	51	M. M. Buck & Co	Outfit and supplies	73.40
	52	Ewald Iron Co	Iron	72.61
	53	Fulton Iron Works	Castings, etc	251.42
	54	P. P. Manion Blacksmith and Wrecking Co	Whistle valve	8.00
	55	Wm. Barr Dry Goods Co	Dry goods	159.95
	56	N. O. Nelson Manufacturing Co	Steam fittings	45.48
	57	Charles Miller	Putting up boilers, etc	1,321.32
	58	Theo. H. Teckenbrock	Subsistence	6.02
	59	Gust. Bischoff	......do	397.54
	60	Matt. Monaghan & Co	......do	69.43
	61	G. Traub & Co	......do	56.40
	62	Samuel Cupples Woodenware Co	Outfit	12.75
	63	Moffit-West Drug Co	Drugs	60.26
	64	Anchor Line Store	Outfit and supplies	308.40
	65	......do	......do	488.67
	66	James Ward & Son	......do	218.79
	67	Goodyear Rubber Co	......do	22.90
	68	Pittsburg Coal Co	Coal	283.99
	69	Cairo City Coal Co	......do	160.70
	70	James A. Tappan	......do	140.00
	71	Matt. Monaghan & Co	Subsistence	139.70
	72	Excelsior Manufacturing Co	Stove castings	12.60
	73	James Smith	Services	55.00
	74	St. Louis Stamping Co	Outfit	50.38
	75	Chas. E. Butler	Locust timber	23.00
	76	Sundry persons	Subsistence	93.05
	77	......do	......do	9.75
	78	Hired men	Services	403.00
	79	......do	......do	1,817.83
	80	......do	......do	365.83
	81	......do	......do	1,647.16
	82	......do	......do	310.97
	83	Standard Stamping Co	Outfit	23.63
	84	Pittsburg Coal Co	Coal	220.00
	85	Sundry persons	Subsistence, etc	54.24
	86	J. A. Bailey & Co	Outfit, etc	5.50
	87	E. A. Hitchcock, receiver	Coal	186.88
	88	Peatross, Cameron & Co	......do	200.00
	89	David Nicholson	Subsistence, etc	171.79
	90	Henry A. Koettker	......do	72.15
	91	Elwell & Ward	......do	32.98
	92	Thos. J. Connor	Covering boilers, etc	213.15
	93	Fulton Iron Works	Castings	189.02
	94	A. G. Brauer	Stove castings	5.10
	95	James Ward & Son	Outfit and supplies	138.10
	96	Simmons Hardware Co	......do	65.84

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
First	97	Simmons Hardware Co	Outfit and supplies	$67.29
	98	N. O. Nelson Manufacturing Co	Steam fittings	2.95
	99	Branch-Crookes Saw Co	Saws	55.00
	100	Simmons Hardware Co	Hardware	2.20
	101	Consolidated Coal Co. of St. Louis	Coal	108.50
	102	St. Louis Art Co	Mirror	8.50
	103	J. Kennard & Sons Carpet Co	Carpet and matting	33.84
	104	Peterson & Homes	Crockery	3.75
	105	Parker, Ritter, Nicholls Stationery Co	Log book	3.75
	106	Revere Rubber Co	Hose	75.00
	107	W. J. Johnston	Repairs	5.75
	108	Huse & Loomis Ice and Tranportation Co	Ice	62.01
	109	James Sweney & Son	Repairs	30.88
	110	Samuel F. Myerson	Blank forms	5.00
	111	Hired men	Services	553.00
	112	James Smith	......do	55.00
	113	Sundry persons	Subsistence	63.28
	114	......do	Fuel	34.70
	115	Matt. Monaghan & Co	Subsistence	153.68
	116	Pittsburg Coal Co	Coal	320.04
	117	Consolidated Coal Co. of St. Louis	......do	63.00
	118	Bryden Coal and Coke Co	......do	45.17
	119	Elwell & Ward	Subsistence	21.50
	120	Ewald Iron Co	Iron	15.98
	121	A. S. Aloe & Co	Outfit, etc	11.15
	122	M. M. Buck & Co	Tiller rope	50.40
	123	G. Traub & Co	Subsistence	64.72
Second	1	Hired men	Services	1,729.83
	2	......do	......do	451.67
	3	......do	......do	1,792.50
	4	......do	......do	327.50
	5	James A. Tappan	Coal	140.00
	6	Matt. Monaghan & Co	Subsistence	117.68
	7	Sundry persons	......do	218.67
	8	Gust. Bischoff	......do	237.70
	9	Charles Miller	Repairs	8.50
	10	E. A. Hitchcock, receiver	Coal	48.75
	11	G. W. Fisher & Bro	Outfit, etc.	9.75
	12	Hired men	Services	603.00
	13	......do	......do	1,796.00
	14	......do	......do	405.00
	15	......do	......do	1,818.00
	16	......do	......do	266.00
	17	Maj. A. M. Miller	Mileage	48.96
	18	James Smith	Services	55.00
	19	Sundry persons	Subsistence	116.32
	20	......do	......do	55.90
	21	......do	......do	76.76
	22	P. W. Mulvihill	Supplies	8.50
	23	St. Louis and New Orleans Anchor Line	Freight charges	1.00
	24	E. A. Hitchcock, receiver	Coal	97.50
	25	C. Pichetto	Subsistence	101.52
	26	H. M. Ehrmann & Bros	......do	46.56
	27	Matt. Monaghan & Co	......do	30.60
	28	Joseph Hirsch	......do	208.39
	29	The Oliver-Finnie Grocer Co	......do	73.35
	30	Pittsburg Coal Co	Coal	855.00
	31	Peatross, Cameron & Co	......do	200.00
	32	Peatross, Cameron & Co	Coal	530.00
	33	Cairo City Coal Co	......do	367.10
	34	......do	......do	159.00
	35	Bryden Coal and Coke Co	......do	42.42
	36	Chas. W. Barstow	Oil	4.08
	37	J. D. Streett & Co	Machine wipers	16.30
	38	Goodyear Rubber Co	Rubber boots	9.00
	39	Peterson & Homes	Crockery	13.80
	40	Branch-Crookes Saw Co	Saws	37.80
	41	Anchor Line Store	Outfit and supplies	58.26
	42	James Ward & Son	Supplies	120.06
	43	Huse & Loomis, Ice Transportation Co	Ice	72.42
	44	Fink & Nasse	Subsistence	49.16
	45	Elwell & Ward	......do	34.15
	46	Scharf, Bernheimer & Co	......do	186.68
	47	Francis Whittaker & Sons	......do	297.25
	48	Goddard-Peck Grocer Co	......do	111.00
	49	David Nicholson	......do	17.33
	50	Van Nort Bros	Carbon brushes	1.50
	51	Simmons Hardware Co	Outfit and supplies	68.70
	52	The W. A. Bonsack Lumber Co	Lumber	68.13
	53	M. M. Buck & Co	Supplies	3.65

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
Second..	54	Western Stove Man'f'g Co	Stove fittings	21.35
	55	Day Rubber Co	Hose	56.46
	56	Western Coal and Tow Co	Coal	174.86
	57	Greeley-Burnham Grocer Co	Subsistence	37.41
	58	Gust. Bischoff	......do	155.55
	59	Ewald Iron Co	Iron and steel	38.22
	60	A. S. Aloe & Co	Drafting material	7.10
	61	Revere Rubber Co	Hose	75.00
	62	Pittsburg Coal Co	Coal	360.00
	63	Alex. H. Stewart	Traveling expenses	33.90
	64	Hired men	Services	403.00
	65	Major A. M. Miller	Mileage	98.88
	66	H. C. Wilson	Traveling expenses	34.30
	67	James Smith	Services	55.00
	68	Vicksburg and Greenville Packet Co	Freight charges	6.00
	69	Joe Newman	Drayage	3.00
	70	C. G. Engle	Subsistence	24.80
	71	Sundry persons	......do	47.54
	72	The Oliver-Finnie Grocer Co	......do	503.14
	73	J. H. Coffin & Co	Outfit and supplies	190.02
	74	Jacob Walter	Subsistence	76.79
	75	Hired men	Services	1,783.50
	76	......do	......do	383.33
	77	......do	......do	1,791.33
	78	......do	......do	322.17
	79	Matt Monaghan & Co	Subsistence	219.23
	80	......do	......do	127.03
	81	......do	......do	85.81
	82	Geo. Traub & Co	......do	95.76
	83	Dan. Shea & Co	Repairs	15.00
	84	E. A. Hitchcock, receiver	Coal	146.25
	85	Cairo City Coal Co	......do	197.76
	86	Pittsburg Coal Co	......do	1,052.50
	87	......do	......do	615.00
	88	Joseph Hirsch	Subsistence	67.60
	89	Valentine Resch	......do	52.05
	90	Western Coal and Tow Co	Coal	118.99
	91	Moffitt-West Drug Co	Medicines	4.34
	92	The W. A. Bonsack Lumber Co	Lumber	96.08
	93	Charles Miller	Sheet iron work	7.50
	94	Rob't D. Patterson Stationery Co	Envelopes	11.35
	95	Elwell & Ward	Subsistence	41.41
	96	James Sweney & Co	Steam pipe	344.85
	97	James Ward & Son	Outfit and supplies	210.01
	98	Simmons Hardware Co	......do	43.43
	99	Gust. Bischoff	Subsistence	121.36
	100	Anchor Line Store	Outfit and supplies	24.00
	101	Huse & Loomis Ice and Transportation Co	Ice	12.78
	102	Hired men	Services	403.00
Third....	1	James Smith	......do	55.00
	2	Sundry persons	Subsistence stores	33.92
	3	C. Pichetto	Subsistence	67.90
	4	Natchez Ice Co	......do	18.40
	5	Hired men	Services	1,791.58
	6	......do	......do	382.42
	7	......do	......do	1,087.00
	8	......do	......do	899.00
	9	Rob't Armstrong	......do	150.00
	10	Peatross, Cameron & Co	Coal	702.12
	11	H. M. Ehrmann & Bros	Subsistence	29.20
	12	J. Hirsch	......do	127.67
	13	Matt. Monaghan & Co	......do	81.43
	14	......do	......do	163.32
	15	Jacob Walter	......do	34.44
	16	Valentine Resch	......do	35.90
	17	The Oliver-Finnie Grocer Co	......do	43.13
	18	Cairo City Coal Co	Coal	145.70
	19	G. Traub & Co	Subsistence	69.04
	20	Pittsburg Coal Co	Coal	610.00
	21	......do	......do	390.00
	22	The W. A. Bonsack Lumber Co	Lumber	23.32
	23	Consolidated Coal Co. of St. Louis	Coal	126.00
	24	James Ward & Son	Supplies	152.67
	25	Anchor Line Store	Outfit and supplies	78.17
	26	Simmons Hardware Co	......do	10.81
	27	Laflin & Rand Powder Co	Powder	20.00
	28	Ewald Iron Co	Iron	131.65
	29	Paddock-Hawley Iron Co	......do	32.00
	30	Wrought Iron Range Co	Stove, etc	19.00
	31	Western Stone Manufacturing Co	Stove and fittings	20.30

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
Third	32	The Goodyear Rubber Co	Rubber boots	$17.00
	33	Van Nort Bros	Carbon brushes	1.50
	34	Huse & Loomis Ice and Transportation Co	Ice	18.60
	35	Gust. Bischoff	Subsistence	98.17
	36	Francis Whittaker & Sons	do	181.33
	37	Elwell & Ward	do	41.29
	38	Fink & Nasse	do	167.00
	39	David Nicholson	do	270.15
	40	Goddard-Peck Grocer Co	do	64.55
	41	James Smith	Services	55.00
	42	Hired men	do	563.00
	43	do	do	1,806.34
	44	do	do	354.00
	45	do	do	1,215.00
	46	do	do	913.00
	47	The Oliver-Finnie Grocer Co	Subsistence	398.33
	48	J. H. Coffin & Co	Outfit and supplies	103.14
	49	Lee Bros. & Co	do	40.19
	50	The Livermore Foundry and Machine Co	Engineer's supplies	6.17
	51	Cairo City Coal Co	Coal	328.30
	52	Jacob Walter	Subsistence	55.02
	53	Valentin Resch	Subsistence, etc	37.30
	54	Major A. M. Miller	Mileage	140.96
	55	E. E. Furney	Traveling expenses	1.10
	56	Hired men	Services	603.00
	57	do	do	1,683.01
	58	do	do	471.00
	59	The C. R. Ryan Grocery Co	Subsistence	138.89
	60	G. Traub & Co	do	82.84
	61	Matt. Monaghan & Co	do	275.97
	62	do	do	124.73
	63	H. M. Ehrmann & Bros	do	72.75
	64	Natchez Ice Co	do	16.00
	65	J. Hirsch	do	74.75
	66	Pittsburg Coal Co	Coal	1,440.00
	67	Jas. A. Tappan	do	240.00
	68	Peatross, Cameron & Co	do	200.00
	69	Hired men	Services	1,235.00
	70	do	do	898.00
	71	St. Louis, Iron Mountain & Southern Rwy. Co	Commutation ticket	12.25
	72	James Smith	Services	50.00
	73	Carnegie, Phipps & Co., limited	Steel beams and plates	684.68
	74	Dan. Shea & Co	Repairs, etc	50.00
	75	Matt. Monaghan & Co	Subsistence	89.66
	76	Valentin Resch	do	18.48
	77	Jacob Walter	do	41.93
	78	Cairo City Coal Co	Coal	72.40
	79	Jas. A. Tappan	do	160.00
	80	Pittsburg Coal Co	do	240.00
	81	do	do	1,440.00
	82	Peatross, Cameron & Co	do	130.00
	83	Jas. A. Tappan	do	80.00
	84	J. Hirsch	Subsistence	98.52
	85	George Traub & Co	do	79.60
	86	C. Pichetto	Subsistence	21.00
	87	Natchez Ice Co.	do	12.00
	88	Mattingly Bros	do	7.20
	89	The Oliver Finnie Grocer Co	Outfit and subsistence	45.32
	90	The Consolidated Coal Co of St. Louis	Coal	114.55
	91	Elwell & Ward	Subsistence	26.15
	92	Huse & Loomis Ice and Transportation Co	Ice	17.56
	93	Matt. Monaghan & Co	Subsistence	83.64
	94	Western Coal and Tow Co	Coal	84.00
	95	John Lowell	Subsistence	63.00
	96	Theo. Lind & Son	do	20.16
	97	The Lodge & Davis Machine Co	Shaper	387.10
	98	Cairo City Coal Co	Coal	47.00
	99	Valentine Resch	Subsistence	15.70
	100	Hired men	Services	603.00
	101	do	do	1,310.50
	102	do	do	1,282.50
	103	do	do	169.66
	104	do	do	126.00
	105	E. A. Hitchcock, receiver	Coal	105.62
	106	Elwell & Ward	Subsistence	10.25
	107	The W. A. Bonsack Lumber Co	Lumber	124.16
Fourth	1	Harrison Matson	Services	45.00
	2	Carl Setz	Subsistence	12.62
	3	Chas. W. Barstow	Outfit and supplies	94.94
	4	James Ward & Son	do	220.75

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
Fourth	5	Fulton Iron Works	Repairs	$119.79
	6	Francis Whittaker & Sons	Subsistence	40.88
	7	David Nicholson	do	153.71
	8	Bischoff-Gregg Meat and Vegetable Co	do	184.76
	9	do	do	192.37
	10	Henry A. Koettker	do	31.85
	11	Huse & Loomis Ice and Trans. Co	Ice	7.86
	12	Simmons Hardware Co	Outfit	5.25
	13	Robt. D. Patterson Stationery Co	Log book	4.50
	14	John J. Ganahl Lumber Co	Lumber	330.52
	15	James Smith	Services	4.67
	16	Anchor Line Store	Supplies	26.54
	17	Ewald Iron Co	Angle iron, etc	16.52
	18	Carl Setz	Subsistence	15.75
	19	Hired men	Services	553.00
	20	do	do	1,130.00
	21	do	do	214.00
	22	do	do	1,330.32
	23	David Nicholson	Subsistence	309.73
	24	Francis Whittaker & Sons	do	85.80
	25	Bischoff-Gregg Meat and Veg. Co	do	243.15
	26	do	do	90.45
	27	Huse & Loomis Ice and Trans. Co	Ice	25.05
	28	Consolidated Coal Co. of St. Louis	Coal	66.75
	29	Buxton & Skinner Stationery Co	Stationery	5.36
	30	Page & Tolkacz	Supplies	2.30
	31	Anchor Line Store	Supplies	86.26
	32	Simmons Hardware Co	do	1.70
	33	James Ward & Son	do	175.41
	34	N. O. Nelson Manufacturing Co	Outfit	98.76
	35	Chas. W. Barstow	Paints, etc	49.06
	36	John J. Ganahl Lumber Co	Lumber	90.92
	37	Ewald Iron Co	Rivets, etc	31.89
	38	Hired men	Services	603.00
	39	do	do	1,306.00
	40	do	do	1,037.50
	41	do	do	275.00
	42	Peter Griffin	do	9.33
	43	G. E. Meissner	Subsistence	3.00
	44	Carl Setz	do	19.37
	45	Jere Haldeman	Traveling expenses	1.00
	46	St. Louis, Iron Mountain and Southern Rwy. Co.	Commutation tickets	8.90
	47	T. L. Crawford	Administering oaths	1.00
	48	Bischoff-Gregg Meat and Vegetable Co	Subsistence	256.01
	49	do	do	208.01
	50	Ranken & Fritsch Foundry and Machine Co.	Castings	170.70
	51	John J. Ganahl Lumber Co	Lumber	58.65
	52	E. E. Furney	Traveling expenses	9.00
	53	Wm. Barr Dry Goods Co	Outfit	170.14
	54	David Nicholson	Subsistence, etc	112.51
	55	E. W. Moon	Parts of machinery	69.30
	56	The Consolidated Coal Co. of St. Louis	Coal	15.80
	57	James Ward & Son	Supplies	58.19
	58	Anchor Line Store	do	29.17
	59	James Sweeney & Son	Copper bends	13.00
	60	C. H. Van Dike	Ice	13.65
	61	Peterson & Homes	Crockery	28.65
	62	Chas. W. Barstow	Paints	79.20
	63	Huse & Loomis Ice Transportation Co	Ice	78.99
	64	Ewald Iron Co	Iron	52.06
	65	Fulton Iron Works	Casting	8.00
	66	Paddock-Hawley Iron Co	Angle iron	28.93
	67	John J. Ganahl Lumber Co	Lumber	46.14
	68	Western Coal and Tow Co	Coal	57.54
	69	Drey & Kahn	Glass, etc	21.20
	70	Simmons Hardware Co	Hardware	11.33
	71	James Ward & Son	Supplies	54.30
	72	Anchor Line Store	do	42.27
	73	Chas. W. Barstow	Paints	95.90
	74	Fulton Iron Works	Castings and I beams	66.50
	75	Pentland & Hahn	Brass blocks	2.40
	76	Francis Whittaker & Sons	Subsistence	30.79
	77	Ewald Iron Co	Iron	85.25
	78	The Bell Telephone Co. of Mo	Telephone subscriptions	50.00
	79	Bischoff-Gregg Meat and Vegetable Co	Subsistence	374.59
	80	David Nicholson	do	348.26
	81	Carl Setz	do	22.25
	82	Hired men	Services	1,306.83

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Quarter.	Voucher.	To whom paid.	For what paid.	Amount.
Fourth ..	83	Hired men	Services	$1,220.66
	84	Jerry Cross	...do	35.00
	85	Edward Culver	Traveling expenses	13.00
	86	Huse & Loomis, Ice and Transportation Co.	Ice	52.15
	87	Hired men	Services	300.00
	88	Buxton & Skinner Stationery Co	Stationery	.91
		Total		98,250.00

TABLE No. 2.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River during fiscal year 1892, as required by section 7 of the river and harbor act of August 11, 1888.*

	1891.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Office expenses	$403.00	$242.12	$369.15	....	$613.10	$248.65
Supervision	200.00	200.00	200.00	....	448.96	298.88
Expenses of snag boat H. G. Wright:						
Crew	2,770.18	2,183.66	....	2,181.50	2,201.00	2,166.83
Outfit	101.70	874.83	215.64	....	279.06	159.27
Fuel	....	575.59	609.16	48.75	840.88	1,043.01
Subsistence	43.39	1,356.94	372.78	237.70	975.82	523.62
Supplies	45.93	124.40	84.48	....	156.15	103.53
Repairs	95.10	281.66	300.98	8.50	152.10	153.21
Miscellaneous	12.25	30.60	....	....	....	4.34
Expenses of snag boat J. N. Macomb:						
Crew	2,769.16	1,958.13	....	2,120.00	2,084.00	2,113.50
Outfit	141.19	664.81	125.65	9.00	....	29.43
Fuel	....	317.75	569.13	140.00	1,945.00	1,052.50
Subsistence	613.45	1,271.89	323.57	336.35	694.53	951.68
Supplies	.80	364.61	7.08	.75	3.50	112.10
Repairs	4,393.38	2,631.38	258.05	....	....	413.34
Miscellaneous	....	29.66	3.75	....	34.90	4.00
Storeboat Abert	....	55.00	55.00	....	55.00	55.00
Total	11,589.53	13,163.03	3,494.42	5,082.55	10,484.00	9,432.89

	1892.						Totals.
	Jan.	Feb.	Mar.	Apr.	May.	June.	
Office expenses	....	$766.00	$403.00	$353.00	$406.76	$150.91	$3,955.69
Supervision	....	542.06	200.00	200.00	200.00	218.90	2,708.80
Expenses of snag boat H. G. Wright:							
Crew	$2,174.00	4,314.35	1,310.50	1,330.32	1,315.83	1,220.66	23,168.33
Outfit	65.15	....	387.10	11.38	63.00	53.10	2,210.23
Fuel	661.70	874.30	614.95	....	....	28.77	5,297.11
Subsistence	1,108.67	364.54	199.03	538.21	205.41	661.67	6,587.78
Supplies	144.27	17.75	25.75	32.46	25.05	41.59	801.36
Repairs	297.00	....	50.00	430.03	122.36	180.99	2,071.93
Miscellaneous	....	....	12.25	....	....	13.50	72.94
Expenses of snag boat J. N. Macomb:							
Crew	2,136.00	2,128.00	3,711.16	1,389.00	1,312.50	1,306.83	23,028.28
Outfit	....	45.15	2.00	1.25	37.52	188.72	1,244.72
Fuel	1,372.12	1,320.00	1,837.87	....	41.70	28.77	8,624.84
Subsistence	436.77	908.29	442.20	101.59	571.14	835.54	7,487.00
Supplies	....	95.18	1.94	20.82	14.40	75.45	696.63
Repairs	....	9.17	808.84	318.37	296.02	667.23	9,795.78
Miscellaneous	....	....	....	4.50	1.60	.50	78.91
Storeboat Abert	55.00	55.00	50.00	4.67	....	35.00	419.67
Total	8,450.68	11,439.79	10,056.59	4,735.60	4,612.79	5,708.13	98,250.00

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND ILLINOIS RIVERS.

PROJECT.

The object of the improvement is to obtain a minimum depth at low water of 6 feet from the mouth of the Illinois River to St. Louis, a distance of 41 miles, and 8 feet from St. Louis to the mouth of the Ohio River, a distance of 191 miles, the natural depth being in many cases from 3½ to 4 feet. The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, working down stream from that city. Work at detached points has also been carried on under allotments specially made by law for the improvement of landings and the protection of local interests.

The plan of general improvement contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles, and the protection of the alluvial banks from erosion. The methods employed are to build up new banks with the solid matter caught from the river itself by means of hurdles and revetment of the banks, both new and old, when necessary.

ORGANIZATION.

The organization of the engineering staff during the season was as follows:

A supervising engineer was assigned to the general supervision of all the works and of the supply depot. His office was in St. Louis, and his duties were to advise and direct the resident engineers and to have especial charge of the supply of brush, stone, and piles, and of the towboat and barges engaged on the work.

The resident engineer was provided with quarters and an office at the work. His duties were to have immediate direction of the work of construction; to make such surveys and observations as might be required; to keep the progress map, upon which all work was to be located as fast as constructed; to keep the journal and other records of the work; to prepare pay rolls; to render quarterly property returns, semiannual and annual reports to the officer in charge, forwarding them through the superintending engineer.

The superintending engineer was Mr. D. M. Currie. Resident engineers, at Alton, Ill., Mr. William S. Mitchell; at Rush Tower, Mr. C. D. Lamb during the fall season and Mr. John O. Holman during the spring season; at Ste. Genevieve, Mr. William S. Mitchell during the fall and Mr. John O. Holman during the spring season. The procurement of brush was in charge of Mr. C. D. Lamb.

WORK ACCOMPLISHED.

Work was carried on during the year at Alton, Ill., Rush Tower, and Ste. Genevieve. Repairs to plant were made whenever necessary, and the new plant contracted for during the last fiscal year was completed and delivered. Eight gauges were established at short intervals between Jefferson Barracks and Jones Point and readings were made daily.

ALTON.

The work at Alton consisted in the extension of the present submergeable stone dike, for a distance of 2,400 feet, and in raising the crest of old dike 3 feet, for a distance of 800 feet at the lower line.

The object of the work is to prevent the formation of a bar in front of the landing at Alton by directing the flow of water at low stages along the river front at that place. A contract was entered into for this work with Mr. H. S. Brown, of Quincy, Ill., under date of January 28, 1891, and operations were commenced on August 10, 1891, and completed, as far as the present appropriation would permit, on May 3, 1892. One hundred and ten piles, 45,400 cubic yards brush, and 17,422 cubic yards of stone were used in the work. The details are given in the report of Mr. William S. Mitchell, assistant engineer, which is forwarded herewith.

During the prosecution of the work and since then the Missouri River has been at a higher stage than the Mississippi River, causing backwater from the former, which so deadened the current that the work has as yet had but little effect on the bar in front of the landing. It requires a high water in the Mississippi, with a low water in the Missouri, before there is sufficient current to wash away the bar. The amount expended was $49,948.78.

RUSH TOWER.

Operations at this locality consisted in the construction of hurdles on the east side near James Landing, also hurdles on the west side near Wilcox, and in the protection of the bank at Calico Island.

At the close of the previous fiscal year work was in progress on hurdles Nos. 4 and 5, east side. These, as well as Nos. 2 and 3, were completed, and the bank between Nos. 4 and 5, which was rapidly caving, was revetted.

A large portion of the river flowed down the west side, spread out into three channels. To close these and force the water over to the east side of the river, three hurdles, Nos. 3, 4, and 5, were built. Owing to bed rock it was not possible to build the full length of these hurdles in the usual manner. They were extended as far out on the bar as was practicable at the stage of water and were then connected with the Missouri bluff shore by solid stone and brush dikes. During the winter and spring the hurdles were seriously damaged by ice and high water, those on the west side being nearly swept away, with the exception of the stone dikes. This work was all repaired, as well as the high and rapidly fluctuating stages of the river would permit.

The hurdles built aggregate 9,710 linear feet, of which 5,920 feet were on the east and 3,790 on the west side.

The protection of a portion of Calico Island became necessary, as the change in the direction of the current caused it to cave rapidly. A mattress 4,000 feet long by 120 feet wide was constructed and sunk so as to cover the eroded portion, and stone revetment was placed on 1,350 feet of the bank above the upstream end. The details of the work are shown in the reports of Mr. D. M. Currie, assistant engineer, and Mr. John Holman, superintendent, forwarded herewith.

The effect of this work can not be observed until low water, at which time it is expected that the water will be found confined in one channel. The amount expended was $181,066.

STE. GENEVIEVE.

This work was nearly completed at the close of the last fiscal year, and it only remained to finish it by sinking drift on hurdle No. 2, wattling and placing curtains on hurdles Nos. 3 and 4, and driving the lower row of piles on hurdle No. 4, all of which was accomplished by July 17. During the month of March the wattling on the hurdles was raised to the 20-foot stage to induce a further fill. The reports of Mr. D. M. Currie, assistant engineer, and Mr. John O. Holman, superintendent, forwarded herewith, show the details of the work.

This work has accomplished the object aimed at, namely, the retention of the channel at Little Rock, which is the landing for Ste. Genevieve. The amount expended was $31,223.82.

PLATES.

Plate 1 is a general map of the river from the Merchants Bridge to Brickeys Mill, and shows the location of the works, with the exception of the Alton Dam, which is shown on Plate 2. The work accomplished during the year at Calico Island and Rush Tower reach is shown on a larger scale on Plate 3.

MATERIAL.

Brush and poles were obtained by hired labor, a royalty of 5 or 10 cents per cord being paid to owners of land where brush was cut.

Stone was obtained by contract from the Grafton Quarry Company at 45 cents per cubic yard, with the exception of a small quantity purchased in open market during the season of low water, the delivery in either case being upon Government barges at the quarries.

Piles were obtained by contract, during the first half of the year, from Mr. John Cleary, at prices varying from 6 to 8 cents per linear foot, according to length, delivered, and by purchase in open market during the last half of the year, at prices varying from 4¾ to 6¾ cents per linear foot, delivered on barges.

Rope, bolts, wire, spikes, nails, etc., were purchased by contract when large quantities were needed; otherwise in open market.

SUPPLY DEPOT.

All supplies, except stone, brush, and piles, were delivered at the depot, foot of Arsenal street, St. Louis, and thence distributed on approved requisitions to the several works. In addition to this function of the depot it is a general repair shop and yard, where all repairs to plant not requiring dockage were made.

REPAIRS OF PLANT.

The steamer *Gen. Gillmore* was taken out on the ways at Carondelet, where new cylinder timbers were put in and other extensive repairs made. Necessary repairs were also made to pile drivers, barges, quarter boats, and all floating plant. The 13 model barges, contracted for during the previous fiscal year, were completed and delivered.

A reference to the report of Mr. S. S. Van Norman, who had immediate supervision of the supply depot and of the repairs, which is forwarded herewith, will show all details of the work.

VALUE OF PROPERTY.

The present value of the property belonging to this work is shown in the following table:

Class of property.	Balance June 30, 1891.	Debits.*	Credits.†	Balance June 30, 1892.
Barges, model and flat	$56,306.41	$61,934.75	$26,225.00	$92,016.16
Boat, machine shop	800.00	1,599.51		2,399.51
Boats, small	13,757.12	132.49	4,225.64	9,663.97
Drivers, pile	39,992.95	550.73	7,650.00	32,893.68
Shanties, portable	7,598.34		1,443.69	6,154.65
Steamer General Gillmore	11,742.07	2,988.86	2,002.99	12,727.94
Launches, steam	6,466.62		1,000.00	5,466.62
Tents	190.75			190.75
Supply depot	3,812.76		371.76	3,441.00
Tools and appliances	4,397.65	745.18	2,110.27	3,032.56
Boarding outfit	9,661.89	618.61	966.19	9,314.31
Office furniture	385.63			385.63
Surveying instruments	456.70	157.00		613.70
Photographic apparatus	200.48	29.68		230.16
Total	155,769.37	68,756.81	45,995.54	178,530.64

* Includes only extraordinary repairs and additions.
† Includes only assumed deterioration.

GAUGES.

The gauges at Grafton and Grays Point were read daily during the year, and the readings are appended, marked A.

Eight new gauges were also established at intervals between Jefferson Barracks and Jones Point, and were all read daily. The object of these gauges was to observe if any change in slope of the water surface was caused by the works of improvement.

CONDITION OF THE RIVER.

The channel depths, as furnished by the Mississippi and Ohio Rivers Pilots' Association for the year, are appended, marked B. A full list could not be obtained, as the pilots' reports are not all preserved by the association.

The river was closed to navigation by ice from January 7 to February 5, 1892. The stage of water was lowest in October, 1891, when it fell to standard low water. The highest stage was reached on May 19, 1892, when the reading on the St. Louis gauge was 36 feet. This is the highest stage since 1858. The record shows but three higher known stages, viz, 37.11 in 1858, 36.61 in 1851, and 41.39 in 1844. The river therefore was to within 5.39 feet of the highest known stage, that of the flood of 1844. Standard low water, reading 4 feet on the gauge, the oscillation of the river was 32 feet.

During the period of lowest water, channel depths in the improved portion were reported as small as 4.5 feet with the lead.

Owing to low water and lack of business the Anchor Line packets were laid up for three months, viz, October, November, and December, 1891.

The water has not as yet subsided sufficiently to show the effect of the recent high water, but it is probable that large deposits have been made behind the hurdles, and that a much improved channel will result during the coming low water season. The works now extend for a distance of 35 miles below St. Louis.

ESTIMATE.

The amount that can be profitably expended during the year ending June 30, 1894, is $1,000,000. It is proposed to expend this sum in carrying out the programme heretofore adopted; that is, to carry on the work of improvement continuously from St. Louis downstream, reclaiming land by building up new banks, thus reducing the river to an approximate width of 2,500 feet, alluvial banks to be protected from erosion. It is proposed to obtain by this means a channel of at least 8 feet at low water. The depth is now liable to become as small as 4 feet or even less in some places, and less at every locality where the width is more than 2,500 feet.

This general statement of the proposed application of the appropriation is as specific as the nature of the case admits. The changeable character of the river renders it impracticable to give in advance the exact locality where works will be required.

The original estimated cost of this work, as revised in 1883, was $16,997,100; the aggregate amount appropriated to June 30, 1892, is $4,529,600; the amount expended to June 30,1891, $4,129,014.16.

Abstract of appropriations made for this work:

By act of—		By act of—	
June 10, 1872	$125,000	June 14, 1880	320,000
March 3, 1873	200,000	March 3, 1881	620,000
June 23, 1874	200,000	August 2, 1882	600,000
March 3, 1875	200,000	July 5, 1884	520,000
August 14, 1876	229,600	August 5, 1886	375,000
June 18, 1878	240,000	August 11, 1888	300,000
March 3, 1879	200,000	September 19, 1890	400,000

Money statement.

July 1, 1891, balance unexpended	$400,365.84
June 30, 1892, amount expended during fiscal year	276,168.99
July 1, 1892, balance unexpended	124,196.85
July 1, 1892, outstanding liabilities	3,827.58
July 1, 1892, balance available	120,369.27
Amount appropriated by act approved July 13, 1892 *	525,000.00
Amount available for fiscal year ending June 30, 1893	645,369.27
Amount (estimated) required for completion of existing project	11,942,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894 †	758,333.33
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. WILLIAM S. MITCHELL, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report on the construction of the extension to Alton Dike during the fiscal year ending June 30, 1892:

The original dike was built in 1882 and 1884. It extends from the Missouri shore above the tow-head of Ellis Island 4,850 feet downstream and diagonally across the river to within 1,250 feet of the Illinois shore at a point 700 feet above the pump-

* This appropriation was made for improving Mississippi River between mouths of the Ohio and Missouri Rivers.

† For continuing work between mouths of the Ohio and Missouri rivers.

house of the Alton waterworks. Up to the level of low water it was constructed of mattresses, each about 80 feet long, 40 feet wide, and 2.5 feet thick, of brush laid in two crossed crosses between grillages of poles and sewed through with wire rope. These mattresses were built on ways on the Missouri shore above the head of the dike, and after having been launched were sunk with stone in their proper places in tiers, each tier overlapping that next below it 10 feet toward the channel, thus giving the proper slopes to the sides of the dike, and the whole was dressed with stone. Above the brush work the dike was raised with stone riprap to a height of 14 feet above low water for 4,000 feet of its length. At that point the height dropped to 9 feet, and thence the dike sloped off to 3 feet above low water at its lower end. When the extension was begun last fall the work was found in excellent condition, but its crest was about 2 feet lower than when built. This was probably not due to settling, but to ice passing over the dike when running out after each breaking up in the spring.

The extension was begun August 10, 1891, and was completed May 3, 1892. It is 2,400 feet in length and extends from the lower end of the old work to a point about 70 feet below the center line of Piasa street, approaching within 1,100 feet of the Alton levee at low water. It does not follow the prolongation of the old dike, but diverges from it about 2° 30′ towards the Missouri shore. The new work is similar in plan to the old, except that the mattresses were increased in width to 50 feet and were built and launched continuously from way barges instead of in sections from ways on shore. They were guided into place by piles spaced 50 to 100 feet apart and were in four tiers for 2,100 feet of the dike, three tiers for the remaining 300 feet, and for 140 feet at about the center of the work, where it crossed the deepest water encountered on the line, a fifth tier was required.

The mattress work and as much of the stone work as was required to bring the level of the whole to 185.5 feet above the office datum plane, or 3½ feet above Alton low water, were completed December 16, when work was stopped for the winter. In the spring it was resumed March 17 and continued until May 3, during which time the lower 800 feet of the old dike and 2,100 feet of the new, which were at about the same level, were raised with stone 3 feet or to 188.5 feet above the office datum. This work exhausted the appropriation and the dike is left with the following profile:

Four thousand feet (old work) with its crest 4 to 6 feet and 12 feet above low water; 2,900 feet (800 feet old work 2,100 feet new work) with crest 12 feet wide and 6 feet above low water; 300 feet (new work) with crest 16 feet wide and 3½ feet above low water.

Throughout the time of construction of the extension the Missouri River was higher than the Mississippi and in consequence backwater from the former so deadened the current at this locality that the work has had but little effect on the deposit in the Alton Harbor, which it is intended to remove. At least one high water from the Mississippi at the time of a lower stage in the Missouri must be had before any material change can be expected.

All work was done by contract by Mr. H. S. Brown, of Quincy, Ill., in accordance with the plans and specifications prepared in this office, and the long-continued low water of last fall and the absence of current during the entire working season were most favorable for the prosecution of the work. Had the contractor's plant been larger and the supply of brush and stone by subcontractors more prompt, the entire work might easily have been completed last fall.

The accompanying chart shows the location of the new dike and the comparative depths found at the beginning and ending of the work on it, and the following table gives the details of expenditures and the quantities of material used:

Pile timber, for guides, 110 sticks, 3,691 feet, at 10 cents	$369.10
Brush, for mattresses, 9,413 linear feet by 50 feet by 2.605 feet, 45,400.67 cubic yards, at 65 cents	29,510.44
Stone riprap, 8,371.65 cubic yards, for sinking mattresses, 9,050.09 cubic yards above low water, 17,421.74 cubic yards, at $1	17,421.74
Engineering and contingencies	2,698.72
Total expended = appropriation	50,000.00

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report upon the improvement of the Mississippi River, between the Illinois and Ohio rivers, for the fiscal year ending June 30, 1892, and to transmit the reports of assistants in local charge, which are intended to form part of it.

Works were prosecuted at Rush Tower and Ste. Genevieve.

Rush Tower.—This locality extends from the foot of Lucas to the foot of Fish Bend, and the works this year include the protection of the bank at Calico Island, hurdles on the east side near James Landing, and hurdles on the west side near Wilcox; all located as shown on the accompanying sketch.

Work was in progress on hurdles Nos. 4 and 5 on the east side at the beginning of the year. The only navigable channel was there, impinged against the bank above No. 4, and was eroding it to a distance of 375 feet below No. 5. A large portion of the river flowed down the west side, divided into three streams or chutes, one down the Missouri shore, another crossing below, and the third above Osborne tow-head.

To prevent further erosion of the east bank a low-water protection mattress was placed from a point 295 feet above Hurdle No. 4 to a distance of 1,570 feet downstream to the lower end of the erosion. The chute down the Missouri shore was then closed, when a navigable channel opened in that above Osborne tow-head. The hurdles on the east side were then extended as nearly to completion as was practicable at the low stage of water which prevailed, and their foundation mattresses were completed.

On the west side the hurdles were extended as far out on the bar as was practicable at the stage of water and connected with the Missouri shore by solid stone dikes, which were built as far as the depth of the earth on the bed rock was insufficient to hold piles.

The river was closed by ice during the winter, and when it opened the hurdles on the east side were found intact with the exception of small breaks in Nos. 2, 3, and 4. On the west side the damage was more serious. There was a break 300 feet long in No. 3, while of Nos. 4 and 5 little remained except the stone dikes connecting them with the shore.

During the spring, No. 2 on the east side was repaired and completed and No. 3 on the west side was extended to connect with the bar at high stages, and the old work was in part repaired. The break near its west end remained open when field operations were closed on account of the flood stage May 7, while its connection with the bar had been severed.

The hurdles built aggregate 9,710 linear feet, of which 5,920 feet are on the east side and 3,790 feet on the west.

During the spring the stages of river fluctuated rapidly, high water causing suspension of work twice before it was closed in May by the flood.

Protection.—The protection of a portion of Calico Island became necessary, the direction of the current having changed so as to impinge with eroding force against its west face about 1,500 feet below its head. A mattress, below standard low water, 120 feet wide and 4,000 feet long, was placed to cover the eroded section. A revetment of stone was placed on 1,350 feet near the upstream end of the mattress and to such heights as were practicable without excessive grading, ranging between 10 and 20 feet above extreme low water.

The quantities of work, material expended, and other details are shown in the report of Mr. John O. Holman, superintendent.

Ste. Genevieve.—The work at this locality was in continuation of that in advanced progress at the close of the last fiscal year, consisting of hurdles Nos. 2, 3, and 4. These were completed by sinking drift on No. 2 and wattling and placing curtains on Nos. 3 and 4.

For the quantities of work, material expended, and other details reference is made to the accompanying report of Mr. John O. Holman, superintendent.

Material.—Brush was procured by hired labor and purchase of royalty. Details are shown in the report of Mr. C. D. Lamb, superintendent.

Stone was procured by contract from the Grafton Quarry Company, with the exception of a small quantity purchased in open market during the season of low water, the delivery in either case being upon Government barges at the quarries.

Piles were procured by contract delivered at the works during the first half of the year and by purchase in open market delivered on Government barges during the last half.

Other materials, including rope, wire, spikes, nails, and bolts, were purchased by contract when needed in large quantities, otherwise in open market.

Plant.—The steamer *Gen. Gillmore* was taken out on the ways at Carondelet and extensively repaired, including new cylinder timbers.

Thirteen model barges, Nos. 101 to 113, inclusive, which had been contracted for and were in process of construction at the close of the last fiscal year were finished.

The other plant received such repairs as were needed.

Details relating to the repairs and other operations at the Engineer Depot are shown in the report of Mr. S. S. Van Norman, superintendent.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report of operations at Rush Tower for the fiscal year ending June 30, 1892:

The work done on the Rush Tower stretch consisted of hurdles in James Chute on the east side, hurdles on the west side near Wilcox, and protection work at Calico Island.

Hurdles.—At the beginning of the fiscal year two hurdles, Nos. 4 and 5, had been started on the east side just above Lillys Landing, and as the bank at that place was cutting very fast the shore mattress of No. 4 was extended down to connect with No. 5 hurdle. This mattress, 650 feet long, July 1 was extended to a distance of 375 feet below No. 5 and 220 feet upstream above No. 4, making the low-water protection continuous for a distance of 1,570 feet, but the only revetment placed was the usual amount at the ends of the hurdles. The piling on these hurdles was completed to the channel, a distance of 100 feet from the shore, early in July.

To cause a fill on the Illinois side of the chute inducing more water to run down the Missouri shore, hurdles Nos. 2 and 3 were begun July 20. By the middle of August these hurdles had been extended a distance of 850 and 650 feet, respectively, causing such a fill at the end of No. 4 that this hurdle was built to a length of 600 feet in the early part of September.

These hurdles, completed to the channel, largely increased the current on the Missouri side, but the channel there was divided below Kennett's between the two Osborne towhead chutes and the chute down the Missouri shore past Wilcox, all of which were too shoal for steamboat channels. To shut off the channel next the Missouri shore the construction of hurdles was begun near Wilcox on September 14.

Three hurdles were built across this chute, Nos. 3, 4, and 5. The piling and foundation mattress on these lines were completed October 17, but the dikes of stone and brush which were placed at the shore end of each line, where piles could not be driven on account of bed rock, were not completed until the last of November. The mattress on these lines, however, was carried well out upon the bar, and the hurdle piles were tightly curtained as soon as driven, so that nearly all the water running down past Kennett's was turned through the Osborne chutes. The lower chute soon began cutting, but any considerable increase in depth was prevented by the gravel bar which was found there at a 1-foot stage. Meanwhile the upper chute was cutting slowly, and on October 12 this channel, though narrow, was of sufficient depth to carry any boat then running on that part of the river.

The closing of the east or James Chute was then resumed and hurdles Nos. 2, 3, 4, and 5 were completed from the towhead to the work done during the summer. A scour which developed under the foundation mattress of No. 2 hurdle near the shore end early in December was checked by placing a mattress 320 feet in length by 45 feet in width above the drift row. An extra row of piles was driven just above the weakened hurdle to protect it from drift.

The force was then disbanded and the plant towed to the winter harbor December 10.

All of the hurdles, except No. 5 east side, were broken more or less by the flow of ice during the winter, the loss amounting to 580 feet of the 5,550 feet on the east side and 1,500 feet of the 2,790 feet on the west side, or a total of 2,080 feet out of the 8,340 feet constructed during the fall season.

Field operations for the repair of the upper hurdle on each side of the river were resumed March 4. Hurdle No. 2, east side, was repaired in March. Two breaks, one of 280 feet and one of 50 feet, were redriven and the hurdle extended 40 feet nearer the towhead. A row of clumps, 3 piles in each, was also driven just above the drift row along the middle portion of the hurdle to protect the broken piles from drift. The small amount of drift collected at the main shore end was sunk and the extension at the towhead was wattled.

In hurdle No. 3, west side, a break of 300 feet just outside of the shore dike was the

only loss from the run of ice, but during the storms of March the remaining drift row, 940 feet in length, gave way without damage to the hurdle row. A row of three-pile clumps 12 feet apart was driven immediately below to strengthen the hurdle row while sinking the drift collected above it.

The east end of the hurdle, which could not be driven in the low stage prevailing in the fall season, was completed to the towhead, a length of 800 feet. The construction of the foundation mattress for this portion of the hurdle was greatly retarded by the strong current and the quick rises of the river over the 26-foot stage April 7 and 22, each rise causing a suspension of several days. The loss of 160 linear feet of mattress just before the second break made the completion of the hurdle more difficult owing to the greater depth and increased current through the break. A large body of drift was sunk above the old portion of the hurdle, the mattress placed on it averaging from 40 to 60 feet in width. Drift mattress was also placed above the new portion with exception of 150 feet near the towhead, but the quantity of drift sunk was not as large.

At the west or shore end, 200 linear feet of hurdle had been driven in the gap when the first rise carried it away. After the second rise another attempt was made to close it. A row of clumps, four piles in each, was driven 170 feet above the line of the hurdle, and 40 linear feet of mattress had been constructed, when the rise of May 7 swept it away.

Work for the season was then closed, and later in the month the plant was taken to the harbor at Bushberg.

Method of construction.—The ordinary forms were used, except in the construction of the foundation mattress at the main shore end of hurdles Nos. 3 and 4, on the east side, which was built across the channel during the high water of July and August. The current was so strong on these hurdles that the driftpiles driven to hold the mattress were scoured out before it could be sunk. The mattress, therefore, was placed before the piling, that on No. 3 hurdle being held during construction by lines to clumps of piles, 75 feet apart, about 200 feet above the line of the hurdle, the mattress on No. 4 hurdle by lines fastened to No. 3 hurdle. The same method was used in the extension of No. 3, west side, during the high water of April, but in this case the mattress was held by clumps only 75 feet above the hurdle. The distance was found too short for the depth of water, but the steamboat channel passing just above prevented any increase of distance. This method of placing the mattress obviates all danger of scour between the piles when they are driven, but it is slower and more expensive.

The Illinois shore was revetted up to a 20-foot stage for the usual distance above and below the ends of the hurdles, but the towhead opposite was protected by the extension of the foundation mattress to the edge of the willows, a distance of 50, 125, 175, and 250 feet respectively from the piling on each line. Curtains made with a 4-inch mesh were built to a 6-foot stage on No. 2, a 12-foot stage on No. 3, and to the stringer at a 16-foot stage on Nos. 4 and 5 hurdles.

On the west side the curtains of Nos. 4 and 5 were carried to the stringers and on No. 3 only to a 6-foot stage. The dikes at the shore ends of these hurdles were built of brush mattresses up to a 4-foot stage and from that plane to 12 feet above low water with stone, 700 yards of which was procured from the bank in the immediate vicinity. Each mattress was about 3 feet thick and 50 feet wide, and all above the bottom tier were placed about 12 feet farther upstream than the one next beneath it. Two tiers were used on No. 3, four on No. 4, and three on No. 5 hurdle, so that the bottom of the dikes varied in width from 60 feet on No. 3 to 85 feet on No. 4, about two-thirds of which were on the downstream side of the crest of the dike. The length of the lower dike was 150 feet, the others 175 feet.

Protection.—The construction of mattress to protect the west shore of Calico Island was begun October 19, 1,500 feet below its head and about 200 feet above the foot of the bar outside, which extends to the Lucas hurdles.

This mattress was built on flats and placed with its inner edge at a 4-foot stage where possible. The ordinary width was 120 feet, but it was made wider when necessary to protect a bay or excess on its inner edge. Construction was continuous down to station 15 + 50 feet or to a point 1,550 feet below the head of the mattress, where it was launched from the ways and sunk, as the mattress showed signs of breaking. Construction was then resumed and the mattress was made continuous to station 40, when work was suspended for the season, December 9. The total amount built was 4,000 linear feet, or 489,750 square feet, completing the low water protection on that part of the island that seems in immediate danger of erosion.

The revetment was begun November 24 at station 1+35, the head of last season's erosion, and carried up to a 20-foot stage down to station 7. The next 200 feet was revetted to a 15-foot stage, and from station 9 to 14+85, to a 10-foot stage. The portions left unprotected are very steep, but will probably be graded by the current during the next high-water season.

The revetment placed amounts to 1,350 linear, or 69,800 square feet.

Work done—Hurdles and bank protection.

Hurdle.	East side.				West side.			Total.
	2.	3.	4.	5.	3.	4.	5.	
Piles driven ....number..	1,124	875	739	676	1,737	323	426	5,900
Stringers placed.........do....	233	164	171	144	312	58	87	1,169
Piling built ....linear feet..	1,800	1,360	1,430	1,330	2,240	775	775	9,710
Foundation mattress ....do....	1,450	1,530	1,605	1,600	2,495	875	800	10,355
Do..........square feet..	98,940	111,650	109,725	104,200	171,675	56,875	52,000	705,065
Drift mattress.....linear feet..	170	....	....	....	1,990	....	....	2,160
Do..........square feet..	5,400	....	....	....	98,785	....	....	104,185
Wattling and curtains..lin. ft..	1,000	1,000	1,050	1,150	650	450	775	6,075
Do..........square feet..	13,400	17,175	22,825	18,650	2,925	7,100	16,875	98,950
Shore dikes........linear feet..	....	....	....	....	175	175	150	500
Do........... cubic feet..	....	....	....	....	2,200	4,825	2,040	9,065
Revetment ....linear feet..	230	155	270	200	....	....	....	855
Do..........square feet..	6,120	2,205	8,100	6,000	....	....	....	22,425

Shore mattress between hurdles Nos. 4 and 5.

Linear feet 1,100
Square feet 108,100

Calico Island protection.

Mattress ....square feet.. 489,750
Revetment..linear feet.. 1,350
Revetment ....square feet.. 69,800

All of the employés were subsisted at the works. The largest number employed in November was 397, which was the maximum.

During the fall season the work was in charge of Mr. C. D. Lamb, superintendent.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report of operations for improving the Mississippi River at Ste. Genevieve, Mo., during the fiscal year ending June 30, 1892.

The system of hurdles at this locality was nearly completed at the close of the previous fiscal year under the direction of Mr. William S. Mitchell, superintendent.

The continuation of the work in July completed the foundation mattress to the river end of hurdle No. 4, the driving of the lower row of piles, the revetment at the shore end and the wattling of the hurdle row with curtain mattresses to the 10-foot stage. Hurdle No. 3 was also wattled with curtains to the same stage. The drift, collected at the shore end of No. 2, the upper hurdle, was sunk. This hurdle was not wattled, as the drift which had been sunk before the entire line answered the purpose.

A large deposit was soon formed under the hurdles after the close of work, July 17. To induce a further fill the wattling of Nos. 3 and 4 was raised to the 20-foot stage, March 11 to 23, 1892.

Hurdle.	Length.	Piles driven.	Stringers placed.	Mattress.	Wattling.	Revetment.
	Feet.	*Number.*	*Number.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*
No. 2..................................	1,500	....	....	8,700	....	....
No. 3..................................	1,350	....	....	....	12,450	....
No. 4..................................	900	324	70	24,830	9,490	1,500
Total..................................	3,750	324	70	33,530	21,940	1,500

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report on procuring brush during the fiscal year ending June 30, 1892:

The force which, on July 1, 1891, was working at Durfees Point, was moved to various places within a few miles of the construction work at Rush Tower, where the brush was used, and was finally disbanded December 2 at Fish Bend and the plant towed into harbor at Bushberg.

Work was resumed for the spring season at Horsetail Bar, east side, near hurdle No. 20. Operations were much interfered with by high water; but little brush was procured at various points in the vicinity until finally disbanded, May 12, on account of the extreme high water.

The brush procured and the time spent at each locality is shown in the following table:

Locality.	Time.	Cords.
Durfees Point	July 1 to July 10, 1891	300.0
Fosters Island	July 11 to July 23, 1891	441.9
Horsetail Bar, west side	July 24 to Aug. 12, 1891	1,037.1
Horsetail Bar, east side	Aug. 13 to Aug. 23, 1891	881.1
Twin Hollows, west side	Aug. 24 to Sept. 1, 1891	1,028.8
Rush Tower Towhead	Sept. 2 to Oct. 29, 1891	3,336.1
Lee's Island	Sept. 26 to Oct. 6, 1891	1,533.4
Penitentiary Point	Oct. 30 to Oct. 31, 1891	406.3
Calico Island	Nov. 1 to Nov. 6, 1891	323.4
Fish Bend	Nov. 7 to Dec. 2, 1891	1,647.7
Horsetail Bar, east side	Mar. 2 to Apr. 19, 1892	1,105.3
Carrolls Island	Apr. 20 to Apr. 25, 1892	210.9
Beards Island towhead	Apr. 26 to Apr. 30, 1892	420.6
Jim Smiths	Apr. 30 to May 4, 1892	243.2
Illinois shore, near Fosters Island	May 5 to May 12, 1892	288.6
Total		13,204.4

All the brush procured during the year was loaded with the derrick, which, as at present arranged, will handle about 50 cords of brush per hour with a force of 8 laborers and a steam engineer.

Very respectfully, your obedient servant,

C. D. LAMB,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. S. S. VAN NORMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit my report of operations at the engineer depot for the fiscal year ending June 30, 1892:

Towboat.—The steamer *Gen. Gillmore* was hauled out on the ways July 28, where her cylinder timbers, fan-tails, and 161 outriggers were renewed, and such minor repairs made as were found necessary and not practicable while the boat was in the water.

The boat was taken off the ways August 12, and the additional repairs incident to renewal of the cylinder timbers were completed at the depot.

A water-closet was also rebuilt, the boiler deck-rail repaired, 40 floor timbers in the hull renewed, 2 carlins put in under the deck at the after-cabin bulkhead, and 10 kevels and 4 fenders made.

Launches.—The stack knees of No. 2 were renewed and the rudder couplings of both launches changed so as to connect them on the top of the rudders.

The boiler sills, a swinging fender, nosing on the head, and all the wheel buckets, except one, were also renewed on No. 2, and the machinery repaired and launch painted.

Pile-drivers.—The machinery of Nos. 1, 2, 10, 13, 16, 18, and 20 was thoroughly repaired and the rake ends of all the drivers were calked, most of them twice and a few three times during the year.

Renewal of different part[illegible] the drivers were made as follows:

Three leads, 2 on No. 18 and 1 on No. 20; 4 timber heads, 1 on No. 10 and 3 on No. 20; 1 sill to leads on No. 20; 1 crab frame and 10 stanchions under beams on No. 11; 6 side braces to leads, 1 on No. 12, 1 on No. 13, 1 on No. 16, 1 on No. 18, and 2 on No. 20.

A mast was also placed on No. 4 for use in connection with other appliances in loading brush.

Besides, the following repairs were made as found necessary:

Patching and calking decks, splicing braces, renewing kevels, patching cabins, and painting cabins and smokestacks.

Five models of drivers were also constructed.

Barges.—Thirteen new barges, numbered from 101 up, were built under contract at Cincinnati, Ohio, and added to the fleet. Thirty-six gas-pipe pumps were made and placed on barges, and all barges calked above the light water line as required.

A side dock was placed under No. 26 and the seams and butts below water line were calked.

Models of five barges were also made.

Barges with quarters.—Nos. 16, 17, 18, 19, 21, 22, 24, 25, and 26 were calked on the sides, and minor repairs, such as patching quarters and decks, made.

Models of two quarter barges were made.

Machine shop.—The old hull of pile-driver No. 15 was repaired and fitted up as a machine shop, as follows: The upper strakes of gunwales on both sides, six rake plank, the deck frame, and deck, and most of the bottom planking were renewed. A cabin 26 feet long by 16 feet wide, with a skylight 8 feet by 16 feet, was built on the hull, and the interior provided with a vise bench and two vises, a drill press, gas-pipe vise, rack for gas-pipe, sixty bins for gas-pipe fittings, forge and anvil, and a locker.

New engine timbers were laid and the engines, boiler, lathe, and shafting placed and lined up.

The hull and cabin were painted two coats.

Small boats.—Ninety-five flats were repaired by renewing timber-heads, renewing and splicing head-blocks and deck stringers, and calking as required.

Ways for mats were placed on 3 flats, platform built on 2, dunnage renewed on 5, and ways for stringing piles erected on 4.

One skiff was built and 35 skiffs and 22 yawls were repaired.

Tools and appliances.—A mast, 18 water gauges, 4 pump plungers, and 15 pump boxes were made, and 50 cant hook, 14 pike, 20 axe, 3 hatchet, and 2 spike maul handles prepared.

A grindstone, 31 blocks, 21 wheelbarrows, and a plane table shade were repaired.

Boarding outfit.—Fifty meat boxes were made, 3 water coolers repaired, and seats of 24 chairs renewed.

Portable building.—Six and a half sections were repaired and erected on barge No. 26, the inside being whitewashed and the outside painted.

Supply depot.—A photographic dark room was built; a vise post and bench and a drill press were fitted up in the blacksmith shop; the roofs of warehouses repaired; the depot fences and sheds whitewashed; cellar steps in warehouse rebuilt, and the sills, platform, and a corner iron of the wagon scales renewed.

Very respectfully, your obedient servant,

S. S. Van Norman,
Superintendent.

Maj. A. M. Miller,
Corps of Engineers, U. S. A.

Construction account, showing total cost of works to June 30, 1892.

Name of work.	Expended prior to July 1, 1891.	Expended during fiscal year ending June 30, 1892.	Total cost to June 30, 1892.
Piasa Island Dam	$37,910.41		$37,910.41
Piasa Island Dam, cutting channel	3,116.86		3,116.86
Alton Dam	33,740.05		33,740.05
Alton Dike	76,703.96	$49,948.78	126,652.74
Sawyer Bend, protection	96,803.63		96,803.63
Venice Dikes	36,341.85		36,341.85
St. Louis Harbor	117,470.42	26,578.52	144,048.94
Arsenal Island, protection	42,599.06		42,599.06
Closing Cahokia Chute	119,958.21		119,958.21
Channel opposite St. Louis	58,455.54		58,455.54
Horsetail Bar, dikes 1 to 5 inclusive	225,066.31		225,066.31
Horsetail Bar, training wall	81,253.28		81,253.28
Horsetail Bar, hurdles	548,834.08		548,834.08
Horsetail Bar, bank protection	40,993.55		40,993.55
Carrolls Island, hurdle	4,093.58		4,093.58
Twin Hollows, west side, hurdles	248,837.82		248,837.82
Twin Hollows, west side bank protection	31,370.55		31,370.55
Twin Hollows, east side bank protection	128,920.30		128,920.30
Pulltight, hurdles	340,778.57		340,778.57
Beards Island, primary hurdle	7,166.24		7,166.24
Beards Island, bank protection	84,258.76		84,258.76
Jim Smiths, hurdles	365,803.33		365,803.33
Jim Smiths, bank protection	7,569.58		7,569.58
Chesley Island, bank protection	64,416.04		64,416.04
Chesley Island, hurdles	27,808.61		27,808.61
Sulphur Springs, hurdles	177,964.24		177,964.24
Lucas, hurdles	128,056.65		128,056.65
Foster Island	44,296.02		44,296.02
Rush Tower, hurdles	9,333.32	165,435.82	174,769.14
Rush Tower, protection		15,630.18	15,630.18
Fort Chartres Dam	36,812.86		36,812.86
Turkey Island	24,463.85		24,463.85
St. Genevieve, hurdles	36,059.47	11,111.59	47,171.06
Kaskaskia, protection	66,465.62		66,465.62
Liberty Island Dam	5,053.91		5,053.91
Liberty Island, protection	45,129.40		45,129.40
Devils Island, Dike 1	65,871.17		65,871.17
Devils Island, dams 1 and 2	66,526.88		66,526.88
Minton Point, hurdles	33,436.37		33,436.37
Cape Girardeau, primary hurdles	31,930.18		31,930.18
Cairo protection	160,439.82		160,439.82
Total	3,762,110.35	268,704.89	4,030,815.24

Property account.

Class of property.	Value July 1, 1891.	Extraordinary repairs, purchases, and additions.	Assumed, deterioration charged to works of improvement, etc.	Value June 30, 1892.
Steamer Gen. Gillmore	$11,742.07	$2,988.86	$2,002.99	$12,727.94
Launches	6,466.62		1,000.00	5,466.62
Barges, model	51,039.60	49,434.75	22,175.00	78,299.35
Barges, with quarters	5,266.81	12,500.00	4,050.00	13,716.81
Pile-drivers	39,992.95	550.73	7,650.00	32,893.68
Machine shop	800.00	1,599.51		2,399.51
Small boats	13,757.12	132.49	4,225.64	9,663.97
Portable quarters	7,598.34		1,443.69	6,154.65
Tents	190.75			190.75
Supply depot	3,812.76		371.76	3,441.00
Tools and appliances	4,397.65	745.18	2,110.27	3,032.56
Boarding outfit	9,661.89	618.61	966.19	9,314.31
Office furniture	385.63			385.63
Survey instruments	456.70	157.00		613.70
Photographic apparatus	200.48	29.68		230.16
Total	155,769.37	68,756.81	45,995.54	178,530.64

Material account.

Class of material.	Value on hand July 1, 1891.	Value purchased.	Expended and charged to works of improvement, etc.	Value on hand June 30, 1892.
Subsistence	$989.01	$17,921.84	$18,458.42	$452.43
Brush	978.88	14,242.47	14,455.70	765.65
Piles	36.88	22,572.16	20,485.69	2,123.35
Stone	301.25	10,903.98	10,391.89	813.34
Rope	11,476.72	729.25	4,789.53	7,416.44
Wire	1,010.58	....	853.87	156.71
Iron	258.48	140.32	150.50	248.30
Nails	356.26	251.48	349.66	258.08
Spikes	679.07	103.50	444.08	338.49
Bolts	3,152.09	59.73	1,489.43	1,722.39
Lumber	636.68	746.12	991.29	391.51
Oakum	231.29	....	195.05	36.24
Coal	307.09	7,197.59	7,481.77	22.91
Ice	....	1,828.95	1,828.95	....
Miscellaneous material	1,832.66	2,619.78	4,075.88	376.56
Total	22,246.94	79,317.17	86,441.71	15,122.40

Construction account showing cost of works during fiscal year ending June 30, 1892.

Class of expenditures.	Localities.					Total.
	Alton Dike.	St. Louis Harbor, hurdles.	Rush Tower, hurdles.	Rush Tower, protection.	St. Genevieve, hurdles.	
Contract	$49,948.78	....	....	....	....	$49,948.78
Labor and superintendence	....	$12,985.86	$44,721.50	$4,654.08	$3,871.60	66,233.04
General expense	....	1,012.22	10,200.60	593.10	367.72	12,173.64
Towboats	....	2,078.42	16,543.61	1,782.19	1,274.92	21,679.14
Ordinary repairs and care of plant and tools	....	1,080.18	12,784.68	720.54	814.32	15,399.72
Deterioration of plant	....	1,906.10	26,834.80	1,295.96	1,555.56	31,592.42
Subsistence and ice	....	297.32	12,789.58	1,418.37	1,007.04	15,512.31
Fuel	....	129.11	1,657.64	54.91	90.16	1,931.82
Material used in construction	....	7,089.31	39,903.41	5,111.03	2,130.27	54,234.02
Total	49,948.78	26,578.52	165,435.82	15,630.18	11,111.59	268,704.89

Record of gauge at Grafton, Ill., for fiscal year ending June 30, 1892.

[Height of water above a plane 200 feet below St. Louis City Directrix.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1....	197.25	193.89	191.93	190.63	191.40	191.30	192.22	194.63	195.60	198.04	203.20	213.84
2....	198.00	193.90	191.84	190.60	191.38	191.21	192.20	194.26	195.71	198.70	203.54	213.82
3....	198.80	193.90	191.78	190.57	191.32	191.18	192.11	194.00	195.83	199.40	203.90	213.65
4....	199.30	193.83	191.56	190.54	191.35	191.04	191.97	193.75	195.82	201.55	204.30	213.43
5....	199.10	193.79	191.53	190.50	191.36	190.92	191.75	193.82	196.02	204.20	205.70	213.21
6....	198.70	193.73	191.52	190.50	191.32	190.88	191.61	194.53	196.14	206.30	206.60	212.92
7....	198.50	193.68	191.50	190.48	191.30	190.84	191.50	195.10	196.74	207.20	207.65	212.61
8....	198.41	193.20	191.47	190.53	191.27	190.80	191.38	196.50	197.77	207.16	208.55	212.39
9....	198.30	193.10	191.45	190.64	191.31	190.77	191.25	196.92	197.91	206.20	209.45	212.25
10....	198.02	192.35	191.41	190.72	191.39	190.66	193.30	196.90	198.20	205.16	210.30	212.00
11....	197.95	192.80	191.40	190.75	191.46	190.60	193.60	196.75	197.83	204.30	211.24	211.80
12....	197.92	192.82	191.34	190.80	191.50	190.60	193.50	196.51	197.51	203.60	212.00	211.57
13....	196.80	192.76	191.30	190.83	191.52	190.67	193.70	196.24	197.32	203.21	212.96	211.35
14....	196.28	192.78	191.20	190.87	191.57	190.80	193.85	196.07	197.20	202.91	213.98	211.15
15....	195.97	193.22	191.15	191.00	191.53	191.18	193.90	195.40	196.93	203.00	214.80	210.91
16....	195.71	193.62	191.09	191.02	191.49	191.43	194.00	195.70	196.70	203.60	215.40	210.70
17....	195.43	193.92	190.90	191.60	191.47	191.60	194.11	195.40	196.54	203.90	215.65	210.67
18....	195.10	194.88	190.83	191.91	191.47	191.82	194.19	195.60	196.38	204.20	215.85	210.50
19....	194.81	195.35	190.80	191.99	191.45	192.31	194.26	196.25	196.20	204.55	215.74	210.21
20....	194.70	195.85	190.77	192.43	191.44	192.73	194.37	198.55	196.11	205.00	215.38	209.80
21....	194.60	196.35	190.71	192.42	191.42	192.81	194.66	199.38	196.03	206.06	215.19	209.65
22....	194.30	196.82	190.68	192.40	191.40	192.78	194.90	198.27	196.08	206.75	215.03	209.42
23....	194.20	196.00	190.64	192.36	191.38	192.72	195.20	197.30	196.18	207.01	214.70	209.34
24....	194.07	195.35	190.62	192.20	191.60	192.66	195.53	196.45	196.30	206.95	214.42	209.33
25....	193.88	195.02	190.63	192.04	191.92	192.57	195.83	195.40	196.51	205.81	214.13	209.48
26....	193.70	194.50	190.62	191.88	191.80	192.51	195.75	195.38	196.70	205.03	214.06	209.53
27....	193.69	193.80	190.60	191.77	191.76	192.47	195.64	195.37	196.31	204.45	213.97	209.60
28....	193.68	193.30	190.63	191.63	191.72	192.38	195.50	195.40	196.90	203.80	213.85	209.87
29....	193.68	192.76	190.67	191.52	191.70	192.32	195.32	195.52	197.07	203.40	213.49	210.29
30....	193.71	192.33	190.66	191.45	191.42	192.26	195.20	....	197.32	203.20	213.76	210.61
31....	193.75	192.15	....	191.40	....	192.25	194.80	....	197.68	....	213.81	....

Standard low water at St. Louis 170.19 feet.
Zero of St. Louis gauge 166.19 feet.

Record of gauge at Grays Point, Mo., for fiscal year ending June 30, 1892.

[Height of water above a plane 200 feet below St. Louis City directrix.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1....	107.11	102.26	99.51	93.61	93.71	93.76	94.26	96.66	103.16	104.01	112.51	120.71
2....	107.56	102.86	98.96	93.46	93.61	93.21	94.51	95.91	103.16	105.36	111.66	120.56
3....	108.76	103.46	98.51	93.26	93.51	92.76	94.66	96.81	102.66	106.06	110.71	120.51
4....	109.56	103.26	97.91	93.06	93.46	92.51	95.31	97.31	102.36	108.36	109.86	120.66
5....	110.41	102.56	97.61	92.96	93.41	92.41	95.66	97.06	101.96	110.66	108.91	120.96
6....	110.56	101.96	97.16	92.86	93.36	92.26	96.76	97.81	101.96	112.71	109.06	121.36
7....	110.26	101.56	96.76	92.86	93.36	92.31	96.76	98.71	102.11	114.81	109.66	121.51
8....	109.36	101.86	96.51	92.86	93.36	92.51	96.06	100.81	101.96	116.01	111.66	121.51
9....	108.26	101.86	96.31	92.86	93.46	92.71	94.71	102.36	102.26	116.61	113.46	121.31
10....	107.46	101.36	96.06	92.86	93.56	92.86	93.71	103.51	103.36	116.51	114.26	121.06
11....	107.26	101.21	95.86	92.96	93.66	92.76	93.71	103.86	105.86	115.91	115.16	120 66
12....	107.56	100.71	95.71	93.11	93.66	92.51	93.61	103.76	106.46	115.06	115.66	120.16
13....	107.71	100.61	95.56	93.41	93.66	92.31	91.81	103.36	106.16	113.66	116.86	119.66
14....	107.46	100.61	95.41	93.81	93.56	92.36	90.56	102.81	105.46	112.56	118.46	119.06
15....	106.56	100.21	95.26	94.51	93.51	92.46	90.36	102.06	104.76	111.81	120.26	118.51
16....	105.86	99.66	95.16	94.71	93.66	92.61	90.86	101.36	104.01	111.61	121.06	117.86
17....	105.51	99.61	95.01	94.96	93.76	92.71	91.41	101.06	103.86	111.51	121.71	117.16
18....	105.31	100.26	94.86	95.06	93.76	92.96	92.51	100.96	102.81	111.51	122.31	116.56
19....	105.16	100.76	94.76	95.11	93.76	93.11	92.06	100.56	102.26	111.66	122.76	116.01
20....	104.86	101.91	94.66	95.11	93.81	93.36	92.81	100.46	101.91	112.76	123.16	115.16
21....	104.21	103.11	94.56	95.01	94.01	93.56	93.51	101.06	101.66	114.31	123.41	114.51
22....	103.76	105.46	94.41	94.86	94.16	93.66	94.36	105.66	101.36	115.36	123.51	113.86
23....	103.41	107.26	94.36	94.76	94.61	93.81	94.76	105.96	101.36	116.11	123.36	113.06
24....	102.86	106.91	94.26	94.56	95.06	94.06	95.21	105.16	101.26	116.36	123.16	112.36
25....	102.66	105.66	94.16	94.51	94.76	94.21	95.31	104.06	101.71	116.26	122.86	112.11
26....	102.51	103.76	94.11	94.46	94.81	94.36	95.41	103.06	102.16	115.86	122.76	112.36
27....	102.51	104.06	94.01	94.31	95.01	94.51	95.46	102.46	102.36	115.36	122.51	112.71
28....	102.76	103.26	93.91	94.21	94.91	95.66	95.66	102.56	102.51	114.91	122.06	112.86
29....	102.91	102.16	93.76	94.11	94.26	94.61	95.76	103.16	102.41	114.16	121.66	113.06
30....	102.76	101.06	93.71	94.01	93.86	94.31	98.26	....	102.41	113.31	121.06	113.36
31....	102.16	100.21	....	93.91	....	94.16	97.76	....	102.81	....	120.76	....

Standard low water at St. Louis, 170.19 feet.
Zero of St. Louis gauge, 166.19 feet.

Depth of water in feet upon the

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	Arsenal Island.	Quarantine.	Pullight.	Twin Hollows.	Fines Bluff.	Meramec River.	Jim Smith's.	Sulphur Springs.	Harrisonville.
1891												
July 2	17.80	Gen. Gillmore	Down	22½		13½	13½		22½			
8	16.70	City of Hickman	do									
8	16.70	S. H. H. Clark	do	18	18		12	15			19½	
11	16.50	John Gilmore	do	19½			12		15			
11	16.50	Gen. Gillmore	do	18		12	18		18			
15	14.40	City of St. Louis	do				12					
17	13.50	Gen. Gillmore	do	18		10½	15		18			
19	12.90	John Gilmore	do				15		12			
19	12.90	City of Providence	do				10½					
20	12.20	Gen. Gillmore	do	16½	15	9½			9			
21	11.80	Arkansas City	do	15			16½					
22	11.30	City of New Orleans	do				10½	12			19½	
23	10.80	H. M. Hoxie	do	16½	16½		13½		10½		18	18
25	10.50	Oakland	do	12			15				15	10½
26	10.60	Belle Memphis	do				13½		10½		15	
29	10.40	City of Monroe	do				12					
29	10.40	City of Hickman	do				12	12				
30	10.00	S. H. H. Clark	do	15			9	10½			15	
Aug. 2	11.00	City of Providence	do				12					
4	10.20	Arkansas City	do				12		15		16½	
15	7.00	Snag boat J. N. Macomb	do				9					
17	7.70	......do	do									
18	8.50	......do	do									
19	9.40	Gen. Gillmore	do	16½	18	12				12		
26	11.80	......do	do	16½	16½	9			18			
29	8.20	My Choice	do				9					
31	6.50	Gen. Gillmore	do	9½	13½	6½			12	10½		12
Sept. 1	6.10	Arkansas City	do				12		10½	10½		
3	4.70	City of Hickman	do				7			9		
4	4.70	Gen. Gillmore	do	9½	9½	7			9½	10½		9½
5	4.30	Belle Memphis	do	12	12		6		10½		12	
7	3.70	Gen. Gillmore	do	9	7½		6½					
9	3.20	City of New Orleans	do	8					8			
16	2.10	J. P. Jackson	do				5½	10½	7½			
16	2.10	City of St. Louis	do	8	9		5½			9	12	
17	1.90	Gen. Gillmore	do	8	8½		5		6½	9		
23	1.30	......do	do	7	7		4½		6	7½		
26	1.00	City of Cairo	do	9			5½	9	8			
28	.80	Gen. Gillmore	do	6½	7		4½		6½	7½		6½
Oct 1	.50	......do	do	8	7		4½		6	6		6
4	.10	City of Monroe	do									
5	.00	Nellie Spier	do	7	7	5		8½	6½		8½	
8	.00	Gen. Gillmore	do	7	6		4		5½	7		6
12	.80	......do	do	8½	8½		4½		5½			5½
17	2.30	City of Sheffield	do	9							10½	
19	2.20	Gen. Gillmore	do	8½		4½			5½			5½
21	1.90	Ferd. Herold	do	7½			6		7½		8	
26	1.30	Gen. Gillmore	do	8		4½			5½			5½
Nov 5	.40	......do	do	9		5½			6			8½
9	.50	......do	do	9		4½			6			8½
19	.90	City of Sheffield	do				5½		6			
19	.90	Gen. Gillmore	do	9		5			6½			8
25	1.60	Ferd. Herold	do				7½		9			
27	1.20	Gen. Gillmore	do	9½		6½			9			7½
30	.10	City of Cairo	do									
Dec. 26	1.60	Cherokee	do				6		8			
1892												
Jan. 16	Frozen	......do	do				5		5			
Feb. 3	3.20	Crystal City	do		9				9		9	
14	8.80	City of Monroe	do				9					
25	9.40	City of New Orleans	do									
26	8.80	City of Monroe	do				13½					
Mar. 2	10.00	City of Cairo	do									
8	10.00	Gen. Gillmore	do	18		16½			16½	18		
17	10.50	......do	do	15		16½				16½		
28	9.90	......do	do	16		9			13½	18		

ears between St. Louis and Cairo.

Lucas.	Herculaneum.	Swashin.	Calico Island.	Cornice Island.	Osborne towhead.	James Landing.	Kennetts Castle.	Forest Home Landing.	Perry Towhead.	Bush Towhead.	Salt Lake Landing.	Brickeys Mill.	Fort Chartres Landing.	Establishment Creek	Crookes Landing.	Mudds Landing.	Stantons Landing.	St. Genevieve.	Moro Island.
19½																			
									12						15				
									18		18				12		15		
16½						16½		16½	16½	18	16½				12			16½	
18																			
			13½			15		18	13½						12	15			
16½																			
16½			13½			12			13½	15	13½				9			12	
			12												13½				
16½									15										
															12	15			
12				13½		13½									8		13½		
			9					15	13½		15				7	13½	12		
								12	12		15						10½	12	
			15	13½				9	12						9	13½	12		
														8					
15			12			12			13½		12				9				
9								9½	8½		10½					9	9		
									15				9½			12	12		
15						15			12		12				10½			10½	
10½								8			9								
13½								12											
16½									18										
10½				10½		10½			9		12		8		9½			10½	
	12		12	9½															
13½		8½	10½	8		10½			8½		9½		7		7			9	
9½			8½						9		7½		7						
	9½		8½	8½															
8			8	10½		9			9		7		5⅔				6½		
	9½		8½	8½		8½			9	9									
8			8	7½		6½			7½		8	5							
6½			6						5		6		6			6		6	
7½		7				6			8½		6½		6	5½					
	5½		7	7															
	6½		7	7															
7			7½			6½			8½				5½					5	6
	6½		6½	7	4½				8		5								
		6	6	6½	4½														
										6	6		5		5	6		4½	
8½				7½			6½		5		5½		6			5		4½	
		5½	6	5½															
		6½	6½	6½	5				9		6								
						6			9		6		6	6				6	
	6½		6½	6½	5½				9										
								6½			7		6½		5	7			9½
	5½			6½															
	6½		6	5½	5½						4½		4½						
		6	6	5½															
				6½	6						5		4½		5½				
					5½														
		9	9	9							9		6½			9		9	12
					8				9	6									
										5½			5½		7				
																8			
							4½		4½									6	6
	9						9								7½				
								8			9				9				
			15				12			9									
															13½				
				13½	12										15				
					9½				10½						9½				

Depth of water in feet upon the bars

Date.	Stage above standard low water by St. Louis gauge.	Name of steamer furnishing report.	Direction.	St. Genevieve Bend.	Blocks.	Mansecoes.	Liberty Island.	Sheep Island.	Crawford's Landing.	Neeley's Landing.	Moccasin Springs.	Bainbridge.	Schellmanns.
1891.	*Feet.*												
July 2	17.80	Gen. Gillmore	Down										
8	16.70	City of Hickman	do			18				15			
8	16.70	S. H. H. Clark	do		15	16½			16½				16½
11	16.50	John Gilmore	do		15	16½				16			
11	16.50	Gen. Gillmore	do										
15	14.40	City of St. Louis	do		12					12			13½
17	13.50	Gen. Gillmore	do										
19	12.90	John Gilmore	do		12	10½				12			16½
19	12.90	City of Providence	do		12	15							
20	12.20	Gen. Gillmore	do										
21	11.80	Arkansas City	do		15	15							15
22	11.30	City of New Orleans	do		10½	13½					13½		13½
23	10.80	H. M. Hoxie	do	9	12	12	15		15	10½			15
25	10.50	Oakland	do		9½	9½	13½		12	9½			13½
26	10.60	Belle Memphis	do		12	13½	10½				13½		
29	10.40	City of Monroe	do		13½	13½	12						
29	10.40	City of Hickman	do		10½	12	10½			9½	15		13½
30	10.00	S. H. H. Clark	do	9	9	9	8½		12	10½		13½	12
Aug. 2	11.00	City of Providence	do		13½	13½	12						13½
4	10.20	Arkansas City	do		13½		9½			12			
15	7.00	Snag boat J. N. Macomb	do										
17	7.70	do	do										
18	8.50	do	do										
19	9.40	Gen. Gillmore	do										
26	11.80	do	do										
29	8.20	My Choice	do	10½	9	10½	15		12	10½	13½		
31	6.50	Gen. Gillmore	do										
Sept. 1	6.10	Arkansas City	do	10½	7½	9	8				13½		
3	4.70	City of Hickman	do		7	8	7			7½	6½		
4	4.70	Gen. Gillmore	do										
5	4.30	Belle Memphis	do		6	7	8		9	8	13½		8
7	3.70	Gen. Gillmore	do										
9	3.20	City of New Orleans	do		8	8	6		8				8
16	2.10	J. P. Jackson	do	6		7							
16	2.10	City of St. Louis	do	6½	6		9½		8½	6½		7	8
17	1.90	Gen. Gillmore	do										
23	1.30	do	do										
26	1.00	City of Cairo	do	7	6	5	4½		8	6		6	6
28	.80	Gen. Gillmore	do										
Oct. 1	.50	do	do										
4	.10	City of Monroe	do	6	6	5½		4½		5	12	5	6
5		Nellie Spier	do	4½	5	5	8½	5	9	4½		5	7
8		Gen. Gillmore	do										
12	.80	do	do										
17	2.30	City of Sheffield	do	7	6	7		5	5½	5½		6	8
19	2.20	Gen. Gillmore	do										
21	1.90	Ferd. Herold	do	6½	6½		5½		9	7		6½	
26	1.30	Gen. Gilimore	do										
Nov. 5	.40	do	do										
9	.50	do	do										
19	.90	City of Sheffield	do		6½	5		5					7½
19	.90	Gen. Gillmore	do										
25	1.60	Ferd. Herold	do	12	6½	7		6½					
27	1.20	Gen. Gillmore	do										
30	.10	City of Cairo	do				5½			5½			
Dec. 26	1.60	Cherokee	do		5½	5½							
1892.													
Jan. 16	Frozen.	do	do	6	4½	4½	4			4			
Feb. 3	3.20	Crystal City	do		9	9	8						
14	8.80	City of Monroe	do		10½		12						
25	9.40	City of New Orleans	do		12			15					
26	8.80	City of Monroe	do	15									15
Mar. 2	10.00	City of Cairo	do	13½	10½								
8	10.00	Gen. Gillmore	do										
17	10.50	do	do										
28	9.90	do	do										

between St. Louis and Cairo—Continued.

Kinney Point.	Belle Golden.	Devils Island.	Cape Girardeau.	Cape Girardeau Bend.	Jacket Pattern.	Athertons Landing.	Goose Island.	Elkins Landing.	Hackers Bend.	Buffalo Island.	Brewers Point.	Scudder Towhead.	Stannards.	Greenleafs Landing.	Eliza Point.	Ferry Landing.	Incline.	Greenfields.	Cairo Point.
		16½					13½			18	16½				15				
		15					10½				15								
		15					12			16½	12						12		
		16½					13½			13½	10½					13½			
		16½			10½		10½			12	10½								
13½							12			15	12							13½	
		16½			15		12				9½			10½				10½	
		12								10½					13½			9½	
		12	12		10½		10½				8½								
		9½			10½		9½			10½	9			15				10½	
	12	15			15		12			12	10½								
16½	13½				15					12				8½				9	
		13½			10½		10½			9½	9							8⅔	
10½	9½				9		8½			9	9		12	15				8½	
	13½	13½								12									
	12											9						10½	
										9	8½						9	8½	
9	9						9		9½		6½			10½				8	
8	8				9		7		8		7			9				7	
8	7				9		8		9			6½						7	
8	7		10½		7½		7		9			6	8					6	
	6				8		6	8				8							6
6½	5½						6												
7	6				8		6½	6½	8										6
	5			5			4⅝	5½			6½			4½					
	4⅝	6					5½			5		7	6½	9	5				
	5	5	5½	5	6	5½	5		5			6½		6				5	
7	5				8		5½	7	6		8		8	9			5½	6	
7	7½				9		5	7½	7		10½		7½	10½		5½			5½
	5½			5			5½		6				6½	7½					
							6	9				9							
6	6			6½			5												
							7½												
			4				5½	4	5½				6	6					
13½							12												
	16½	16½	18				13½												
		13½					12												

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the years 1889, 1890, 1891.

Articles.	Receipts.			Shipments.		
	1889.	1890.	1891.	1889.	1890.	1891.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barbed wire and ores and metals (pig and manufactured)	31,663	21,782	13,741	5,885	3,945	4,802
Cement	6,876	15,892	18,621	....	....	....
Coal and coke	88,845	81,565	55,980	1,701	734	148
Cotton (and products)	4,663	4,230	2,946	200	527	38
Groceries and dairy products	8,815	8,262	7,604	8,047	7,428	9,675
Hay, seeds, and grain (including flour, meals, etc.)	96,265	92,914	96,526	538,329	440,728	377,416
Jute	3,473	235	....	....	....	....
Live stock and products	12,805	17,347	15,217	15,429	18,379	15,166
Lumber	127,695	132,940	142,090	6,470	8,526	6,245
Merchandise and sundries	281,579	284,589	234,817	131,546	117,806	95,842
Vegetables	7,986	3,530	4,110	2,612	1,739	1,435
White lead, oils, etc	756	204	63	1,799	1,379	1,555
Wines and liquors	102	60	121	647	668	590
Wool	162	180	304	35	2	18
Total	671,685	663,730	592,140	712,700	601,682	512,930

Transferred by ferries across the river at St. Louis.

	Tons.
1889	2,717,760
1890	3,052,166
1891	3,268,753

Shipments down the river from landings between St. Louis and Cairo during the years 1889, 1890, 1891.

Grain, including flour, meals, etc.:	Tons.
1889	29,209
1890	34,267
1891	20,353

RECAPITULATION.

	1889.	1890.	1891.
	Tons.	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	1,384,385	1,265,592	1,105,070
Transferred by ferries at St. Louis	2,717,760	3,052,166	3,268,753
Shipped from landings between St. Louis and Cairo	29,209	34,267	20,353
Total	4,131,354	4,352,025	4,394,176

NOTE.—Increase of 42,151 tons for year 1891 over year 1890.

List of steam-power boats that arrived at St Louis during the year 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Altea	58	10	1.8	8.75
Alert	115	19	3	100.00
Alice Brown	193	34	4	551.36
A. L. Mason	252	52.6	6	1,130.34
Annie Berner	(*)	(*)	(*)	(*)
Antelope	(*)	(*)	(*)	(*)
Archie Parker	70.6	15	6.2	45.16
Arkansas City	273.7	44.7	7.8	1,236.99
A. S. Willis	153.1	26.5	3.6	139.99
A. W. Van Sant	(*)	(*)	(*)	(*)
Bald Eagle	202.3	30	5.4	454.71
Belle Memphis	267	42.7	7.6	1,222.89

* Not known.

List of steam-power boats, etc.—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Benton	197	23	5	394.08
Borealis Rex	121.5	22	4.5	163.16
Calhoun	230	36	5.4	631.74
Charlotte Boeckeler	140	29.4	4.1	143.48
Cherokee	216.4	33.9	5.4	631.20
City of Alma	110	20	4	96.07
City of Cairo	271.2	44	7.8	1,266.12
City of Florence	160	32	5.3	358.31
City of Hickman	285	44.5	9.5	1,555.17
City of Monroe	275	45	8	1,038.25
City of New Orleans	290	48	8.5	1,586.28
City of Paducah	190	34	5.5	318.91
City of Providence	273.1	44.5	7.8	1,303.81
City of Savannah	186	31.2	5.3	335.55
City of Sheffield	183	35	5.5	329.74
City of St. Louis	300	49	8.8	1,614.02
City of Vicksburg	273.7	44.5	8.2	1,356.52
C. R. Suter	189.6	52	7	(*)
Crystal City	234	42.2	7	828.28
Des Arc	95	18	3	40.88
D. H. Pike	199.6	33.5	5.5	465.75
Dick Clyde	95.8	17.4	3.9	76.84
Dolphin	135.8	22.8	4.8	156.16
Dolphin No. 2	150	30	4.5	186.03
Dora	199.5	25.2	4.3	392.23
Eagle	155.6	24.8	4.2	231.30
Edith	101	24	3.1	69.59
Emma	55	13	3	17.68
E. M. Norton	174	30	6	549.53
Ferd. Herold	244.6	34	7.2	900.58
Future City	187.4	36	6.1	589.30
Gem City	263	29.8	5.6	580.56
General Barnard	215	37	5	500.00
General Gillmore	140	28	4	125.00
George Lysle	174	33	6	426.74
Grand Republic	260	50	8.5	1,985.92
Harry Reid	85	18	3.5	58.94
Helena	194	33	4.5	352.31
Helene Schulenberg	130.3	25.4	3.7	107.95
Henry Lourey	209.6	35.2	5.3	646.79
Herbert	134	27	3	316.26
H. F. Frisbie	169.4	32.2	5.8	270.45
H. G. Wright	190	62	8	(*)
Hiawatha	140.5	30	5.5	240.45
H. M. Hoxie	213.2	34.3	5.6	622.30
H. M. Townsend	116.7	18	3.1	89.70
Ida Morse	51.6	10.8	3.2	10.93
Idlewild	207.6	35.6	5.7	520.36
Imperial	89.3	19	4.8	68.08
Iron Age	176	38	5.5	385.91
Iron Duke	177	32.6	6	421.25
Ironsides	154	30	6.4	282.80
Jack Frost	165	30	5.4	350.77
Jas. B. McPherson	(*)	(*)	(*)	(*)
Jay Gould	186.8	30.4	6	446.25
Jennie Campbell	144	26	4	225.16
Jennie Gilchrist	100.5	18.5	3.8	74.48
Jessie B	121	21.6	4.3	78.34
Joe Long	120	22	4.4	130.22
Joe Peters	177.2	34.4	4.8	525.90
John Barrett	124.8	31	5.5	187.23
John Bertram	180	34	5	390.49
John Gilmore	183	34	6	503.09
John L. Ferguson	111.6	25.6	3.6	79.81
John M. Abbott	92	20	3.6	97.78
John N. Macomb	176.9	62	7	(*)
Joliet	97	17.4	7.1	102.65
Josephine	155.2	28.8	4.8	240.77
Josie	143	28	5	237.51
J. P. Jackson	161	29.6	5.5	257.74
Julia	107	22	3.5	58.51
Kit Carson	138.6	29.2	4	237.09
Lady Byron	(*)	(*)	(*)	(*)
Libbie Conger	168	29.5	4.5	324.09
Lily	178	28	4.3	200.00
Little Eagle No. 2	130.7	19.2	3.9	82.65
Lizzie Gardner	124.5	21	3.6	70.54
Louis Houck	210	37	6	913.27
Mary M. Michael	143.3	26.3	4.4	234.34
Mary Morton	210	32.5	6	456.96

* Not known.

List of steam-power boats, etc.—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Maude	106	20.6	4.5	191.26
Mississippi	175	32.5	6	390.14
Musser	137	24	4.6	163.63
My Choice	183	35	5	462.23
Nellie Speer	145.4	27	5	234.19
New Idea	125	26	4	146.61
Niagara	98	17.6	7.2	99.41
Oakland	210	35	6	628.81
Oliver Bierne	265	43.6	7	1,017.78
Patrol	111.6	26	4	121.63
Philip Sheckel	114	20.5	3	108.00
Pittsburgh	250	39.2	5.8	722.17
Polar Wave	146	25.7	5	150.34
Rambler	(*)	(*)	(*)	2.00
Randall	92	19	3	44.49
R A. Speed	124	22	4.2	210.13
Reindeer	125	23	3.3	219.16
Rescue	121	26.8	3.4	139.03
Robert Dodd	128.5	25	5.7	128.61
Sam Brown	177	39	7.2	474.10
Satellite	76.5	15.9	3.9	53.55
S. C. Clubb	85	18	6	52.69
Scotia	100.5	13.4	3	31.57
S. H. H. Clark	210	37.6	6.2	711.67
Sidney	221.3	35.5	3.5	617.88
Sidney Dillon	175	33.8	5.5	420.58
Spread Eagle	224.5	33.8	5 7	529.34
State of Kansas	252	52.6	6	1,130.34
St. Paul	300	36.3	6.2	833.53
Thistle	150	28.5	4.8	103.45
Tom Rees No. 2	168	29	5.4	327.02
Verona	43.2	11	2	6.13
White Eagle	238	29	3.8	312.75
Wm. Stone	136.2	26	4.9	174.00

* Not known.

List of barges and scows that arrived at St. Louis during the year 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Abbott, Nos. 7 and 8	(*)	(*)	(*)	(*)
Adelaide	154.4	28	5	196.24
A. K. Brookbank	(*)	(*)	(*)	733.47
Alaska	(*)	(*)	(*)	(*)
Allegheny	(*)	(*)	(*)	908.69
Anchor Line No. 1	167.5	32.6	7.5	634.82
Anchor Line No. 2	167.5	32.8	7.5	692.19
Angel	(*)	(*)	(*)	(*)
Annie	130.6	19.3	5.6	101.64
Annie Spies	(*)	(*)	(*)	(*)
Annie T	(*)	(*)	(*)	(*)
A. P. Shinkle	(*)	(*)	(*)	(*)
Argent	(*)	(*)	(*)	(*)
Argentine No. 2	(*)	(*)	(*)	58.97
Argentine No. 3	(*)	(*)	(*)	(*)
Bayou Sara	(*)	(*)	(*)	(*)
Boy Blue	200	28.8	8	414.69
Buckeye	(*)	(*)	(*)	48.55
Cape Girardeau Transportation Co. (18 in all)	(*)	(*)	(*)	(*)
Centennial	(*)	(*)	(*)	(*)
Chester	186.4	34.6	7	886.09
Chicago Belle	(*)	(*)	(*)	(*)
Commerce	(*)	(*)	(*)	(*)
Commonwealth	(*)	(*)	(*)	(*)
Continental	(*)	(*)	(*)	(*)
Delia	(*)	(*)	(*)	12.29
Dickey	(*)	(*)	(*)	(*)
Dolomite	154.4	26.8	5	172.49
Dove	(*)	(*)	(*)	685.84
Eagle Sand Company No. 4	(*)	(*)	(*)	(*)
Emma Wilson	(*)	(*)	(*)	(*)
Enterprise Bath	(*)	(*)	(*)	(*)
E. Robinson	(*)	(*)	(*)	(*)
Fannie	153.4	27.9	5	181.08

* Not known.

List of barges and scows, etc.—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	
Garry	(*)	(*)	(*)	133.74
Geogebic	(*)	(*)	(*)	(*)
Gilchrist, Nos. 1 to 3	(*)	(*)	(*)	(*)
Grafton	(*)	(*)	(*)	(*)
Grand Tower, No 2	(*)	(*)	(*)	(*)
Griffith and Adams, Nos. 13, 16, 17, 18	(*)	(*)	(*)	(*)
Helena	186.4	34.6	7	862.16
Homestead	(*)	(*)	(*)	(*)
Illinois	228	37	7.3	1,220.91
Irondale	(*)	(*)	(*)	700.62
Ironsides No. 4	(*)	(*)	(*)	629.46
Jap	(*)	(*)	(*)	(*)
J. Barrett & Sons (6 in all)	(*)	(*)	(*)	(*)
Jennie Flowerree	200	28.8	8	414.69
Jessie	152.4	27.4	5.4	188.72
Josie	152.4	27.6	5.4	197.78
Josie	(*)	(*)	(*)	(*)
Josie S	(*)	(*)	(*)	(*)
Joy Bros. (15 in all)	(*)	(*)	(*)	(*)
J. Walton	(*)	(*)	(*)	(*)
Kennebec	(*)	(*)	(*)	(*)
Kentucky	(*)	(*)	(*)	(*)
Keokuk No. 1	140.6	20.4	3.5	88.58
Leila	154	27.9	5	182.02
Little Dan	(*)	(*)	(*)	(*)
Lone Star	(*)	(*)	(*)	(*)
Louisa	(*)	(*)	(*)	203.83
Lyle & Co (3 in all)	(*)	(*)	(*)	(*)
Mack	(*)	(*)	(*)	(*)
Maggie Monks	212.4	28.3	8	443.52
Mamie B	(*)	(*)	(*)	(*)
Mamie E	(*)	(*)	(*)	204.61
Mandan	(*)	(*)	(*)	(*)
Matt No. 1	(*)	(*)	(*)	(*)
McCormick No. 8	(*)	(*)	(*)	(*)
Metropolis	(*)	(*)	(*)	(*)
Milton	180.6	38.3	7.2	898.91
M. Michael	146	24.2	4.2	118.07
Misso uri Sand Company, Nos. 3 and 4	(*(	(*)	(*)	(*)
Mose	152	26.4	4.6	153.56
Nellie Peck	(*)	(*)	(*)	(*)
New St. Louis Sand Company, No. 5	(*)	(*)	(*)	(*)
O'Neill & Co. (3 in all)	(*)	(*)	(*)	(*)
Orient	(*)	(*)	(*)	669.04
Ostrich	(*)	(*)	(*)	(*)
Pike No. 2	171.6	27.2	5.2	188.79
Pinafore	(*)	(*)	(*)	21.63
P. King	(*)	(*)	(*)	(*)
Rachel	189.6	34.8	6.4	639.50
Rachel	(*)	(*)	(*)	(*)
Randall No. 1	(*)	(*)	(*)	(*)
R. A. Speed, Nos. 2 to 4	(*)	(*)	(*)	(*)
R. G. Ferrel	(*)	(*)	(*)	(*)
Rover No. 1	165	28	6	474.62
Rover No. 2	165	28	6	215.74
Rover No. 3	137.8	28	5.2	158.22
Rover No. 4	138.2	28.2	5.2	156.77
Ruth	179.2	34.7	6.6	759.66
Sangamon Eagle	(*)	(*)	(*)	(*)
Sitka	(*)	(*)	(*)	(*)
Snow	(*)	(*)	(*)	(*)
Sunny Side	(*)	(*)	(*)	(*)
Swan	(*)	(*)	(*)	28.64
St. James	152	27	5.4	194.81
St. Louis and Mississippi River Packet Company, Nos. 1 and 2	(*)	(*)	(*)	(*)
St. Louis and Mississippi Valley Transportation Company—	(*)	(*)	(*)	(*)
No. 20	201.2	35.6	8	1,011.18
21	200.6	36	7.8	1,002.40
22	200.5	36	7.8	1,015.91
23	200	36	8	986.62
24	200.5	35.2	7.3	1,018.84
25	201.4	35.6	7.2	1,020.60
26	203.5	36	7.6	1,060.79
27	200.5	35.6	7.4	1,038.47
29	201	35.6	7.6	1,021.19
30	225.6	34.8	8	1,126.85
32	224.6	34.8	8.2	1,130.69
33	227	35	8.8	1,171.99
34	225.6	34.8	8	1,135.15

* Not known.

List of barges and scows—Continued.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
St. Louis and Mississippi Valley Transportation Company—Continued.	*Feet.*	*Feet.*	*Feet.*	
35	225.6	34.8	8	1,129.63
36	225.6	34.8	8.2	1,166.34
37	227	35	8.4	1,193.11
38	229	36.5	8.3	1,197.31
39	230	36.7	8.3	1,201.29
40	226	36.6	8	1,110.48
41	226	36.4	8.2	1,211.79
42	226	36.2	8.2	1,192.14
44	225	36	8.2	1,164.18
45	210	40.4	8.2	1,287.81
46	224	36.4	8	1,181.26
47	226	37	8	1,179.72
48	226.8	36	8	1,161.10
50	210	40	6.6	1,311.66
52	228	36	8.2	1,177.15
53	203	40.6	6	1,165.81
57	225	36	7.6	1,248.54
58	225	36.3	7.6	1,248.54
59	225	36.3	5.7	1,107.39
60	220.4	32	7.7	1,146.31
61	220.4	32	7.7	1,154.02
62	221.7	34.5	7.5	1,121.53
64	220.8	34.6	7.5	1,096.62
65	219.6	34.7	7.4	1,096.56
66	225	36.3	5.3	1,107.39
67	225	36.8	6.2	1,146.05
70	226	36	6.8	1,164.15
72	227	36.6	6.6	1,171.60
75	226.6	36.3	6.7	1,137.10
77	226.5	36	6.6	1,123.93
78	226	36.6	6.8	1,151.06
79	236	36	6.8	1,163.78
80	227.7	36.2	6.8	1,144.13
81	226.6	36	6.6	1,118.74
82	226	36	6.8	1,101.11
83	226	36	6.6	1,105.29
84	226	36	6.6	1,101.63
85	226.4	36	6.7	1,102.45
86	225.5	36	6.6	1,127.97
87	226	36.6	6.6	1,123.99
88	226	36.4	8.2	1,202.23
89	227.7	36.4	8	1,174.62
90	216.7	36	7.9	1,079.81
91	202.7	35	7.6	998.98
92	216.8	36	8	1,154.49
93	228	37	8.2	1,218.76
95	228.4	37	7.3	1,220.91
96	227.7	37	7.2	1,220.60
97	225.5	36.5	8.1	1,185.64
98	238.4	36.4	8.8	1,237.12
99	226	36.8	8.2	1,141.80
100	228.6	36.6	9	1,274.81
101	225	35	5.3	860.31
102	225	35	5.3	860.31
103	225	36	6.6	835.31
104	225	36	6.6	835.31
105	227.8	31.2	6	1,007.27
106	227.8	31.2	6	1,012.53
Tennessee, and Ohio, and Mississippi River Packet Company, Nos. 2 to 4	(*)	(*)	(*)	(*)
Tom Wells	(*)	(*)	(*)	(*)
Transfer No. 1	(*)	(*)	(*)	229.57
Ukon	(*)	(*)	(*)	(*)
U. S. Engineer Department (10 in all)	(*)	(*)	(*)	(*)
Vidalia	(*)	(*)	(*)	(*)
V. W. Flowerree	200	28.8	8.	414.69
W. H. Brown's Sons (107 in all)	(*)	(*)	(*)	(*)
Whitney	(*)	(*)	(*)	(*)
W. J. V. B., Nos. 1 and 5	(*)	(*)	(*)	(*)
William Gordon	227.7	36.6	6.6	1,262.01
Wood	(*)	(*)	(*)	128.10
Yantic	(*)	(*)	(*)	(*)

*Not known.

X 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

The appropriation for this work was made in the river and harbor act of September 19, 1890, and in submitting the project for its expenditure it was recommended that the money be expended in the portion of the harbor between the Merchants and Eads bridges.

The approved project consisted in the contraction of the width of the river, by a system of hurdles, for a distance of 13,000 feet, to an average width of about 2,000 feet, in order to remove middle bars which interfered with navigation, and improve the ferry landings on the Illinois shore.

Appropriations for the improvement of St. Louis Harbor had been made as far back as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work done by the United States consisted in the building of stone dikes normal to the current, in the closing of Cahokia Chute, and the revetment and protection of the bank in Sawyer Bend.

The present project contemplated the construction of twelve hurdles, and during the previous fiscal year eleven of these, varying in length from 325 to 2,075 feet, were constructed, one hurdle, No. 5, being omitted, owing to the fact that it would interfere with the ferry landing, and the outer end of No. 8 was left incomplete owing to the great depth of water found. During the present fiscal year the work has consisted in building hurdle No. 5; in extending No. 8 to the river line; in repairing Nos. 6 and 7, damaged by drift during the high water of July; in wattling Nos. 2 to 11, and in sinking drift above the hurdles, which served the purpose of wattling.

The result of this work can not be determined until the approaching low-water season. Soundings show that a large fill has taken place along the line of the hurdles, and it is expected that when the water falls the middle bars will be found to have been washed away, and that the ferry landings will be more readily approachable.

The amount expended up to June 30, 1891, was $109,303.77, and during the fiscal year ending June 30, 1892, $41,226.44 were expended. This leaves a balance of $31,469.79, which will be used in repairing any damage to hurdles caused by ice or drift, and in extending the hurdles farther out into the river, should it be found necessary. No further appropriation is needed for this work.

The material used in the work was purchased by contract in connection with that for improvement of Mississippi River, between Ohio and and Illinois rivers, full details of which are given in the report on that work.

The five model barges that were contracted for during the previous fiscal year were delivered and paid for.

There are submitted herewith the reports of Mr. D. M. Currie, assistant engineer, and Mr. John O. Holman, superintendent, also plate 4, by reference to which all details and particulars can be obtained.

The commercial statistics will be found in the report on improvement of Mississippi River between Ohio and Illinois rivers.

The only appropriation for this work was:

By act of September 19, 1890 .... $182,000

Money statement.

July 1, 1891, balance unexpended	$72, 696. 23
June 30, 1892, amount expended during fiscal year	41, 226. 44
July 1, 1892, balance unexpended	31, 469. 79
July 1, 1892, outstanding liabilities	230. 04
July 1, 1892, balance available	31, 239. 75

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report of operations for the improvement of St. Louis Harbor during the fiscal year ending June 30, 1892.

This work was in continuation of that of the preceding year and comprised the construction of hurdle No. 5, and the extension of No. 8, repairs of No. 6 and 7, and completing the obstruction to the flow of water to the stage of 20 feet above extreme low water, by wattling and sinking drift on Nos. 1 to 11, inclusive. On No. 12 the obstruction was left, as at the close of the preceding year, at the stage of 12 feet above the same plane.

In constructing No. 5, repairing Nos. 6 and 7, and extending No. 8, 1,685 linear feet of hurdle was built, and in the whole work 816 piles were driven, 209 stringers were placed, 98,725 square feet of mattress for foundation and 118,185 square feet for sinking drift was fabricated and sunk, 109,735 square feet of hurdle was wattled, and 3,200 square feet of bank was revetted.

The report of Mr. John O. Holman, superintendent, transmitted herewith, contains further details.

Very respectfully, your obedient servant,

D. M. CURRIE,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, SUPERINTENDENT.

ST. LOUIS, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report of the operations for improving the harbor at St. Louis, Mo., for the fiscal year ending June 30, 1892:

The work performed during the year comprised the construction of No. 5 hurdle, the extension of No. 8 to the river line, the repair of Nos. 6 and 7, the wattling of Nos. 2 to 11, and the sinking of drift.

The amount of work done on each hurdle and the lengths driven on Nos. 5 to 8 are given in the following table:

Number.	Length.	Piles.	Depth driven.	Stringers.	Mattress.		Revetment.	Wattling.
					Hurdle.	Drift.		
	Lin. feet.	*No.*	*Feet.*	*No.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*
1						2, 000		
2						3, 150		1, 650
3						7, 500		2, 640
4						6, 435		5, 930
5	880	403	6, 797	111	67, 200	23, 400	3, 200	11, 550
6	275	128	1, 771	33		48, 700		16, 300
7	100	61	897	15		27, 000		21, 120
8	430	224	3, 634	50	31, 525			22, 420
9								10, 200
10								13, 975
11								3, 950
Total	1, 685	816	13, 099	209	98, 725	118, 185	3, 200	109, 735

In constructing No. 5 hurdle, four rows of piles were driven 12 feet apart, with the piles in each row spaced 8 feet apart. Stringers were placed at the 20-foot stage, 2 feet below the tops of the piles, one at each bent of 8 feet and a longitudinal stringer on the upstream row. The mattress was 80 feet in width, 10 feet above and about 30 feet below the piling, with its shore end protected by 3,200 square feet of revetment. This peculiar form was used with a view of allowing the Madison Ferry Company the use of the hurdle for a temporary roadway over it, but the large bar that formed under hurdle No. 4 and the deep water found outside of it have changed their plans.

Owing to the depth of water No. 8 hurdle was not completed during the spring season, but the fill which had occurred after the close of the work, June 9, allowed its extension to the river line.

Hurdles Nos. 6 and 7 were broken at the river ends by the heavy drift during the high water of July, aided by the absence of No. 5. On No. 6, 200 feet was carried away and 150 feet of the drift row broken, the hurdle row below remaining in good condition. On No. 7, 200 feet of the drift row was pushed down against the hurdle row. These hurdles were redriven to the river line, using the old hurdle row as the new line for the drift row.

Wattling was placed on all the hurdles except Nos. 1 to 12, and drift mattresses on Nos. 1 to 7, on the drift which accumulated after the close of the spring season.

No. 1 required only a small mattress at the river end, the drift being well sanded in the full length of the hurdle to nearly the 20-foot stage. Most of the drift on Nos. 2, 3, and 4 was sanded in requiring only small mattresses to hold the loose drift in position. The drift row of these hurdles, Nos. 2 to 4, were wattled from the drift or drift mattress to the 20-foot stage. The wattling on No. 5 was placed on the third row to the 20-foot stage except 250 feet at the river end, where it was raised only to the 12-foot stage. On No. 6, 7, and 8 the wattling was placed on the hurdle row to the 20-foot stage, but only to the 12-foot stage on the new work at the river ends.

In the spring season Nos. 9 to 12 were wattled to the 12-foot stage. The fill under these hurdles allowed the wattling of Nos. 9 and 10 and 700 feet at the shore end of No. 11 to the 20-foot stage.

The drift mattresses on Nos. 5, 6, and 7 were much larger than on the hurdles above the one on No. 6, extending the full length of the hurdle.

The maximum number of persons employed during the forty-nine days of field work was 164, of whom 10 were subsisted.

A sketch of the locality accompanies the report showing the location of the work done. The soundings and bar lines show a large fill over the entire work.

The stage of water referred to in the report and sketch is the stage shown by the St. Louis gauge.

Very respectfully, your obedient servant,

JOHN O. HOLMAN,
Superintendent.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

X 4.

IMPROVEMENT OF GASCONADE RIVER, MISSOURI.

The improvement of this stream has consisted in the removal of obstructions to navigation in the shape of leaning timber, snags, stumps, etc., and the construction of wing dams to facilitate the passage of boats over the shoals during low stages of water.

The work was begun in 1880, and has been continued when funds were available up to the present time.

The principal work of the year consisted in raising the crest of dam at Pryors Mill. This work was commenced on July 1 and completed September 5. Eleven cribs, 16 feet long by 11 feet wide and of an average height of 2 feet, were constructed and placed in position in the old dam. Rock to the amount of 697 cubic yards was deposited in these cribs and in the old structure. This work has been successful in turning the flow of the river, at low water, into the left chute, thereby giving ample depth of water for navigation when boats can pass over the lower bars.

After this work was completed snagging operations were commenced at Arlington and continued to the mouth of the river, a distance of 138 miles. The number of snags, logs, etc., removed was 419; 2,153 trees were cut down, and 8 rack-heaps and 1 bowlder removed from the channel. This work has placed this part of the river in good navigable condition.

The steamer *Pin Oak*, with crew, was hired December 28 to January 1 to remove some channel snags and in the construction of an extension to spur wall at Bocks Bar.

The details of the season's operations are shown in the report of assistant, Mr. J. W. Beaman, which is forwarded herewith.

The unusually high water of this spring has left many snags in the channel, and they will be removed as soon as the water is at a low stage. Training walls will also be built at one or more of the upper shoals in order to concentrate and deepen the water. The balance remaining on hand at the end of the fiscal year will be expended at Bocks Bar and in removing obstructions.

While statistics show that there has been a decrease in the rafting commerce, an increase of 34 per cent has occurred in the general steamboat commerce.

The estimated cost of this improvement was $50,000, but as new obstructions are continually forming, it will require appropriations from time to time to keep the channel open at low water after the principal work has been done.

The former appropriations are:

By act of—		By act of—	
June 14, 1880	$5,000	August 5, 1886	$7,500
March 3, 1881	10,000	August 11, 1888	5,000
August 2, 1882	10,000	September 19, 1890	4,000
July 5, 1884	5,000		

Money statement.

July 1, 1891, balance unexpended	$3,884.04
June 30, 1892, amount expended during fiscal year	2,073.55
July 1, 1892, balance unexpended	1,810.49
July 1, 1892, outstanding liabilities	62.12
July 1, 1892, balance available	1,748.37
Amount appropriated by act approved July 13, 1892	4,000.00
Amount available for fiscal year ending June 30, 1893	5,748.37
Amount that can be profitably expended in fiscal year ending June 30, 1894. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	10,000.00

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report upon the improvement of the Gasconade River, Missouri, for the fiscal year ending June 30, 1892:

At the close of the fiscal year ending June 30, 1891, a small force, composed of a foreman and three men, was employed in quarrying rock at Pryors Dam, 30 miles above the mouth of the Gasconade River. The work of quarrying rock, building cribs, and placing the rock quarried occupied the above force from July 1 to September 5. During this time, eleven cribs, 16 feet long by 11 feet wide by 2 feet average

height, were built, and in them and in the old structure of the dam, upon which the cribs were built, were deposited 697 cubic yards of riprap rock.

As the structure upon which the cribs were built is an old one and somewhat undermined by river action, the stability of the work can be determined at the next low-water season better than at time of completion.

So far the new structure has accomplished what was designed by the project and has proved effectual in turning the whole flow of the river, at the lower stages, into the left chute, thus providing ample water in the "Bend" when there is sufficient water for steamboat navigation on the shoals below.

This work having been completed on September 5, in accordance with your letter of instructions of August 17, snagging operations were begun at Arlington, a point on the river 138 miles above its mouth.

The following table indicates the work done from September 5, 1891, to January 1, 1892, inclusive:

Snags, logs, etc., removed from the channel	419
Trees over 6 inches in diameter felled	763
Trees under 6 inches in diameter felled	1,390
Bowlders removed from channel	1
Rack heaps removed	8
Miles of river worked over	138

By the above the river was cleared of snags and overhanging trees from Arlington to the mouth, a distance of 138 miles, and put in good navigable condition as far as snags and trees were concerned.

From September 5 to December 11 the organization of the force was a foreman, a teamster and team, and two laborers.

From December 28 until the morning of January 1, the steamer *Pin Oak*, with crew of six men, was employed for 42 hours at $2.50 per hour, in the removal of some channel snags, and in the construction of a crib in the extension upstream of the spur wall at right angles to the cross dam at Bocks Bar.

The repair of a break 40 feet in length, in the cross dam, was included in the project covered by your instructions of December 23. A sudden rise of the river prevented the execution of this work of repair.

Since January 1, 198 cubic yards of riprap rock have been quarried and placed ready for quickly filling in the broken part, and the strengthening of the remainder of the cross dam.

As reported by river men, the unusually high water of this spring has left many snags in the channel, which will necessitate in their removal the employment of a force of four men and a team for probably two months or more.

Several of the upper shoals need contraction works similar to those which have been built on the lower river, one or more of which may probably be built with the appropriation yet unexpended.

The year has been a prosperous one for the steamboat trade, as will be indicated by the commercial statistics accompanying this report. The rafting interest is gradually shrinking, due to the scarcity of timber along the banks. These two interests will continue, the one to increase, the other to decrease, as the forests are felled and replaced by fields of wheat.

Very respectfully, your obedient servant,

J. W. Beaman,
Assistant Engineer.

Maj. A. M. Miller,
Corps of Engineers, U. S. A.

Commercial statistics, Gasconade River, Missouri.

Articles.	1890.	1891.
	Tons.	*Tons.*
Hay, grain, seed, etc	2,658	4,035
Lumber, logs, wood, railway ties, etc	22,806	19,646
Live stock	209	425
Produce	5	67
Salt	28	29
Iron, nails, etc	23	3
Farm machinery	115	37
General merchandise	239	216
Totals	26,083	24,458

List of steam-power boats engaged in commerce on the Gasconade River during the year 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Gasconade	107	22	3.3	74
Jumbo	57	16	2.75	25
Pin Oak	95	17.5	2.2	43.05
Royal	86.6	24	3	44.82

X 5.

IMPROVEMENT OF OSAGE RIVER, MISSOURI.

The project for the improvement of this stream has consisted in the removal of obstructions to navigation, such as snags and leaning timber, by dredging channels through shoal places, and the construction of cross and wing dams to concentrate the water over shoal places. The construction of a lock and dam near the mouth of the river was also authorized by the last river and harbor act.

On September 18, a small party was organized for the purpose of removing snags and overhanging trees from the river. Work was commenced at the mouth of the river, and by November 30, when operations were suspended, had reached Big Gravois Shoal, 80 miles above the mouth. Sixty-six snags, logs, etc., were pulled, 342 trees cut down, 42 drift trees were cut up, and 2 rocks removed from the channel. This work has placed this part of the river in good navigable condition.

Discharge observations at Brennekes and Burds shoals were continued, and the results were computed and tabulated. A line of levels was also run from the foot of Rices Island to near the foot of Round Bottom Shoal in connection with the discharge observations. The reading of the gauges at Brennekes Shoal, Osage City, and Burds Shoal were also continued.

An amended plan for the proposed lock and dam near the mouth was made, the lift being changed from 8.5 to 10.5 feet, and the width from 50 to 52 feet. This will increase the proposed channel depth of 4 feet to 6 feet. The estimated cost of the lock and dam is $200,000.

A survey for a reservation at the proposed site of lock was made, and it was requested that condemnation proceedings be instituted by the Attorney-General to obtain possession.

The details of the work are given in the report of Mr. J. W. Beaman, assistant engineer, forwarded herewith.

The readings of the gauge at Tuscumbia were kept up during the year and are given in the accompanying table.

The work done has been of great benefit to the navigation of the river, rendering it safer and also enabling steamboats to navigate it at lower stages of water and for longer periods.

The unusual high water of this spring has probably brought down a fresh supply of snags, which will be removed at low water. It is not proposed to commence work on the lock and dam until a sufficient amount of money has been appropriated to warrant starting it.

Of the amount asked for fiscal year ending June 30, 1894, it is proposed to expend $10,000 in removing obstructions, dredging, and building wing dams when found necessary, and $100,000 in constructing lock,

The former appropriations are—

By act of—		By act of—	
March 3, 1871	$25,000	June 14, 1880	$30,000
June 10, 1872	25,000	March 3, 1881	20,000
March 3, 1873	25,000	August 5, 1886	10,000
June 23, 1874	25,000	August 11, 1888	5,000
June 18, 1878	20,000	September 19, 1890	55,000
March 2, 1879	20,000		

Money statement.

July 1, 1891, balance unexpended	$54,070.53
June 30, 1892, amount expended during fiscal year	5,772.25
July 1, 1892, balance unexpended	48,298.28
July 1, 1892, outstanding liabilities	481.13
July 1, 1892, balance available	47,817.15
Amount appropriated by act approved July 13, 1892	50,000.00
Amount available for fiscal year ending June 30, 1893	97,817.15
Amount (estimated) required for completion of lock and dam	110,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	110,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. J. W. BEAMAN, ASSISTANT ENGINEER.

JEFFERSON CITY, MO., *June 30, 1892.*

MAJOR: I have the honor to submit the following report upon the improvement of the Osage River, Missouri and Kansas, for the fiscal year ending June 30, 1892:

During the year observations for river discharge have been continued, with an intermission from November 29 to April 5. On May 31, 172 computations of river discharge, covering the observations at Brennekes and Burds shoals from May 8, 1891, to November 25, were transmitted to your office.

Gauges have been observed daily through the year at Brennekes Shoal and Osage City, and at Burds Shoal since October 11.

A line of levels has been run from the foot of Rices Island, 13 miles above the mouth of the river, to near the foot of Round Bottom Shoal, 25 miles from the mouth, as other work would permit.

A survey for a reservation within which to construct a lock and dam at the foot of Brennekes Shoal was made September 26, in accordance with your instructions of September 16. A plat and notes of the same was duly transmitted on October 27.

All the above-noted work has immediate connection with the projected improvement of the river by lock and dam.

In accordance with your letter of instructions of July 1, on July 6 and 7 an examination was made of the railway bridge across the Osage River at Osceola, Mo., on the line of the Kansas City, Fort Scott and Memphis Railroad. Of this bridge as an obstruction to navigation, Capt. Otto Marker, master of steamer *Black Diamond*, made complaint to the honorable Secretary of War by letter of June 22, 1891. A report based upon the examination of this bridge was duly transmitted to your office July 8.

In accordance with your letter of instructions of August 18, on September 21 a small party was detailed to remove the snags and overhanging trees from the river. The party consisted of four men and a team with an outfit of capstan, skiff, wagon, and tools, and was employed in snagging until called in on account of bad weather and lateness of the season on November 30.

The work between September 21 and November 30 may be tabulated as follows:

Snags, logs, etc., removed from channel	66
Overhanging trees removed from bank	342
Drift trees along bank cut up	42
Rocks removed from channel	2
Miles of river worked over	80

By the above work the river was placed in good navigable condition, as far as snags and overhanging trees are concerned, from the Big Gravois Shoal to the mouth, a distance of 80 miles.

There is more or less steamboat commerce all along the line of the river from 15 miles above Osceola to the mouth, a distance of 245 miles.

The *Black Diamond*, of 18.4 tons burden, plies from Osceola up the river 15 miles and down the river 60 miles.

The *Annie Dell*, of 19.05 tons burden, runs from Ironton, 135 miles above the mouth, to Tuscumbia, a stretch of 75 miles.

The larger steamboats, *John R. Hugo*, *Frederick*, and *Edna*, run from the mouth to Tuscumbia, a distance of 60 miles, and to intermediate points.

Nothing has been done on the upper Osage River above the Big Gravois since the spring of 1883, when the river was all worked over from the mouth to Osceola.

The high water of this spring, the highest since 1882, will probably leave a new and large deposit of snags all along the line of the river.

These should all be removed, as well as the overhanging trees from the banks, from the mouth to Osceola and above.

The year has been a satisfactory one to local steamboats, as will be indicated by the accompanying statistical table of commerce for the calender year ending December 31, 1891.

Very respectfully, your obedient servant,

J. W. BEAMAN,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Record of gauge at Tuscumbia, Mo., for fiscal year ending June 30, 1892.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.
1	15.00	6.15	1.75	.15	—.05	.95	1.90	1.75	17.20	12.30	8.65	22.90
2	14.45	5.35	1.55	.15	—.05	.90	4.15	2.20	16.65	11.90	8.40	27.85
3	13.75	4.95	1.40	.10	.05	.95	5.30	2.45	16.30	11.85	9.00	31.10
4	12.10	4.40	1.30	.10	.05	1.15	5.75	3.00	15.00	14.90	9.40	32.25
5	9.70	6.05	1.15	.10	.05	1.50	5.90	7.65	13.25	18.25	10.00	31.75
6	8.35	6.30	1.05	.10	.00	1.65	5.75	11.20	10.70	20.35	10.00	30.40
7	7.20	6.60	.95	.15	.05	1.60	5.35	14.50	10.75	19.85	9.95	29.15
8	6.20	6.65	.85	.15	.20	1.50	4.90	16.70	16.80	17.90	10.00	27.00
9	5.30	8.25	.75	.15	.35	1.40	4.40	17.15	19.15	16.50	9.80	25.05
10	5.45	7.10	.70	.15	.40	1.25	3.75	15.65	19.70	15.65	11.45	23.00
11	6.70	5.50	.70	.15	.45	1.20	3.35	14.85	18.40	15.25	12.20	21.45
12	6.80	4.35	.65	.10	.40	1.25	3.25	12.60	17.15	14.50	12.10	19.50
13	6.35	3.50	.60	.10	.40	1.25	3.40	11.25	10.90	12.70	13.95	17.15
14	5.95	3.05	.60	.15	.40	1.20	3.70	9.70	17.10	10.85	19.90	13.40
15	7.20	2.70	.55	.15	.35	1.15	3.35	11.25	17.00	11.30	25.80	9.25
16	9.25	2.35	.50	.10	.75	1.10	3.05	11.40	15.90	10.85	28.50	6.35
17	10.15	2.10	.50	.10	.80	1.00	2.70	10.75	14.75	10.80	30.60	5.90
18	10.20	1.90	.45	.10	1.15	.90	2.25	9.90	13.35	12.40	31.80	5.10
19	9.80	1.75	.40	.10	1.00	.85	2.55	13.95	11.65	9.85	31.35	4.85
20	7.90	1.95	.40	.10	1.05	.80	2.80	19.25	9.20	14.80	29.55	4.80
21	6.05	2.60	.35	.05	1.15	.80	2.65	21.70	6.95	17.70	27.60	4.95
22	6.20	6.05	.35	.05	1.45	.80	2.50	21.15	9.40	16.80	25.00	4.70
23	6.45	5.00	.30	.05	1.75	.75	2.35	18.90	14.85	16.00	22.15	4.40
24	6.10	4.30	.30	.00	1.80	.75	2.10	18.35	17.50	14.80	19.40	4.10
25	6.90	4.10	.25	.00	1.60	.70	1.95	19.50	17.65	13.55	17.25	3.60
26	7.00	4.45	.25	.00	1.35	.70	1.85	22.30	17.40	12.50	16.00	3.15
27	7.05	3.80	.20	.00	1.25	.65	1.80	22.75	16.00	10.90	14.90	3.00
28	7.40	3.15	.30	.00	1.20	.60	1.70	21.90	15.10	9.20	13.65	2.80
29	7.65	2.75	.25	.00	1.15	.60	1.65	19.60	14.15	8.55	13.40	2.65
30	7.80	2.35	.20	—.05	1.00	.55	1.60	....	13.05	8.25	12.55	2.70
31	7.25	2.00	....	—.05	....	.55	1.60	....	12.50	....	14.25	....

Commercial statistics.—Osage River, Missouri and Kansas.

Articles.	1890.	1891.
	Tons.	*Tons.*
Hay, grain, seeds, etc	5,118	6,135
Lumber, logs, wood, railway ties, etc	86,349	77,195
Live stock	766	957
Produce	319	527
Salt	482	602
Barytes	1,710	2,775
Iron, nails, etc	408	510
Farm machinery	453	588
General merchandise	1,408	1,760
Total	97,013	91,049

List of steam-power boats engaged in commerce on Osage River during the year 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Annie Dell	70.	16.	2.	19.05
Benton	197.	33.	5.	398.08
Black Diamond	72.5	14.4	2.3	18.40
Edna	102.	21.5	4.7	83.35
Frederick	96.4	14.3	3.	82.51
Helena	194.	33.	4.5	352.41
John R. Hugo	127.	20.	3.	136.88

X 6.

IMPROVEMENT OF KASKASKIA RIVER, ILLINOIS.

The improvement of this stream has consisted in deepening the water over the two principal shoals between the mouth and Evansville, namely, the Nine Mile Shoal, and the Evansville Shoal, and in removing snags and obstructions from the river. The stream was practically blocked near its mouth during the low-water season by the Nine Mile Shoal, over which there was often a depth of only 9 inches, when the St. Louis gauge read 6.5 feet.

The first appropriation for improving the river was contained in the river and harbor act of September 19, 1890, and by the time the project for its expenditure was approved, the low-water season had passed, and work was deferred until this year.

A party was organized on September 17, 1891, and the improvement was commenced at Nine Mile Shoal, where a channel 75 feet in width and 36 inches deep at low water was excavated through rock, the material removed being placed in a dike 665 feet long on the east side of the channel and in walls on each side of cut, which were to deflect and concentrate the water through the cut. This work was completed October 30. The party was then transferred to Evansville and work was begun on the shoal at that point on November 2, and consisted in excavating a channel whose dimensions were to be 75 feet wide by 36 inches deep, through the shoal. The conditions and character of work at this locality were quite different from the work at Nine Mile Shoal, as the material that was to be removed consisted of stone bowlders and blue clay, mixed with gravel and mussels, in place of rock, as at the former locality, and necessitated the building of a cofferdam inclosing the proposed excavation, in order that the cut might be dug out. Work was continued until December 17, when, the appropriation being nearly exhausted, it was stopped. The channel was not completed up to the desired width, 75 feet, but was 60 feet wide and 34 inches deep. The excavated material, as far as possible, was used in building dikes from either shore and extending along the sides of the cut, to direct and concentrate the water through the new channel. While work was in progress at Evansville Shoal a small party was organized to remove the snags from there to the mouth. Five good-sized snags were removed in the first 1.5 miles below Evansville, when a sudden rise in the river stopped the work.

The details of the season's operations are shown in the report of Mr. Richard Klemm, assistant engineer, which is forwarded herewith and to which attention is invited.

The effect of this work will undoubtedly be very beneficial to the commerce on the river, as steamboats will be enabled to navigate the

stream at lower stages than formerly and for low water seasons of greater length.

Should another appropriation be made for this improvement, it will be expended in completing the work at the Evansville Shoal, in cutting a channel through the shoal at Plum Creek, and in removing snags from New Athens to the mouth.

The estimated cost of the improvement was $10,000; the former appropriation was

By act of September 19, 1890	$6,000

Money statement.

July 1, 1891, balance unexpended	$6,000.00
June 30, 1892, amount expended during fiscal year	5,760.48
July 1, 1892, balance unexpended	239.52
Amount appropriated by act approved July 13, 1892	4,500.00
Amount available for fiscal year ending June 30, 1893	4,739.52

REPORT OF MR. RICHARD KLEMM, ASSISTANT ENGINEER.

ST. LOUIS, MO., *January 2, 1892.*

MAJOR: I have the honor to submit herewith the following report on work done in removing shoals in Kaskaskia River at two places, namely: Shoal near the mouth of Nine Mile Creek, and shoal at Evansville, Ill.

In accordance with your order, a party was organized September 17, 1891, consisting of one assistant engineer and two rodmen. Engineering instruments and working tools were received from the head office and from the Engineer depot, foot of Arsenal street, a list of which is contained in the property return accompanying this report. The party proceeded to Chester, Ill., per steamer *Crystal City*, and from there to Nine Mile Shoal per steamer *Nick Sauer*.

The mouth of the Kaskaskia River was almost closed up by a mud bank so that even the steamer *Little Nick* could enter into the Kaskaskia River only with the greatest difficulty, using her full steam power and a Spanish windlass. The freight was transferred from the *Nick Sauer* to the *Little Nick*, which finally brought us up to the Nine Mile Shoal on Monday, September 21. The stage of water on September 21, 1891, at St. Louis was 5.4 feet. Considerable trouble was experienced in securing board for the party and also for the men that I had hired in Chester and in the neighborhood. A small office building, carpenter, and blacksmith shop was built on the west shore of the river. The building was also used as a sleeping room by myself and party, as we could not get quarters conveniently. A general survey of the shoals was made and two gauges established, one above and one below the shoals. Actual work was commenced on September 24.

The rock in the shoals was found to be a very hard limestone mixed with flint, very difficult to drill, so that skilled drillmen could not drill more than 7 to 7½ feet per day of eight hours with 1¼-inch drills. On account of seams in the rock and the different thicknesses of the ledges, it was impracticable to pay for the drilling by measurement, and the rates of pay for more or less skilled drillmen had to be established by judgment. The holes were drilled 2½ to 3 feet apart, varying in depth from 1 to 2.6 feet, as the thickness of the ledges allowed. For the blasting, Atlas Powder "C" (containing 40 per cent. of nitroglycerin) was used. The 8-inch cartridges were cut in two, the explosive power of such charges having been found sufficient to break the rock into convenient size for handling under water. The loosened and broken-up rock was removed from the bottom of the river by hand, the men using crowbars, wedges, and sledge hammers. The men engaged in this work were provided with hip rubber boots. This part of the work was the most tedious and slow, yet the low stage of water and the warm weather was of great advantage to the work. As shown on the accompanying sketch, a dike was built on the east side of the proposed channel from the shoals to the mouth of the Nine Mile Creek. This dike was built from the material quarried from the shoals and from the old (McBride) cross dike. The opening in the clear of the new channel is 75 feet and 20 inches deep at a St. Louis gauge-reading of 5 feet. The difference of stage of water above and below the shoals was as follows:

September 25, St. Louis gauge, 5.4 feet; difference of stage above and below shoals 0.93 feet. October 18, St. Louis gauge 6.4 feet; difference of stage above and below shoals, 0.20 feet; with no head water from the Kaskaskia, showing that a rise in the Mississippi will extend up to the Ninemile Shoals at a St. Louis reading of 6.4 feet.

The dike at the Ninemile Shoals is 665 feet long, 5 feet wide on top, slope on both sides 1 in 1 (45 per cent) and varying in depth from 2.8 feet to 5.5 feet and contains 1,178.35 cubic yards. The dike projects 2.16 feet above the water line at a stage of 5 feet at St. Louis. The work at the Ninemile Shoal was finished October 30.

The work at Evansville Shoal was commenced November 2. The conditions and character of work at this shoal were quite different from the work at Ninemile Shoals, as the material that had to be removed was more or less alluvial ground, consisting of stone bowlders, blue clay (gumbo) mixed with gravel and muscles. The use of dynamite had to be confined to the large bowlders, as the blue and black clay was too tenacious to be affected by the explosive. Picks, shovels, and wheelbarrows had to be used, and for that purpose the water had to be kept out of the location selected for the new channel. A cofferdam inclosing the proposed excavation was constructed; the materials used were pine posts 4 by 4 inches, varying in length from 2 to 4 feet, 1 inch rough boards (sheathing) 16 feet long. The posts were set 14 inches apart in the cross section and 8 feet apart in the longitudinal direction. The space between the sheathing was filled with material (gumbo) taken out of the excavated portion of the river and all carefully rammed and tamped. Little trouble was experienced with the dam as the clay was water tight, and with the exception of a few places where water leaked in under rocks that could not be removed without great difficulty, the system worked well. A few 3-inch hand pumps were made and a number of buckets procured to keep the place dry.

Two dikes were constructed from the excavated material, as no better use could be made of it and as these dikes are proposed to confine the water at a low stage to the new channel, with a view that the current should keep the new channel clear from all sediment that headwater fro n the Kaskaskia or backwater from the Mississippi might bring. The dike on the east side of the river is the strongest, being 8 feet wide on top and about 2½ feet above the water line at extreme low water. The channel was originally planned for 75 feet, and the dikes are built on that plan, yet this width could not be obtained, as the river rose on November 23 4 feet, filling up the inclosed portion and destroying the lateral cofferdams. This accident caused considerable extra labor and expense. As soon as the stage of water permitted new cofferdams were constructed, and the excavating continued to a depth of 18 inches below the lowest stage of water at the lower gauge. This causing an excavation of 2½ feet on the east side for at least 200 feet, and an excavation of 1½ feet on the west side for a distance of 150 feet, the total amount of material removed from the river amounted to 1,105 cubic yards. The channel now is 60 feet wide, which will allow a boat of the size of the *Nick Sauer* to carry a barge either at the side or at the bow, the channel being perfectly straight.

The dikes at the Evansville shoals contain the following amounts:

	Cubic feet.
Main dike, east shore, 4 feet wide on top, 3 feet high, 280 feet long	5,880
Main dike, east shore, 8 feet wide on top, 5.5 feet high, 160 feet long	11,880
Main dike, west side, 5 feet wide on top, 4.5 feet high, 265 feet long	11,328
Main dike, west side, 3 feet wide on top, 2.5 feet high, 200 feet long	2,750
Total	31,838

The difference of yards excavated and contained in dikes is caused by the handling of the material and by additional rock which was taken from the shore to make the dikes more substantial.

In accordance with your orders work was stopped December 17. A good channel of 60 feet in the clear had been dug out, the main dikes being on the 75-foot line, leaving a strip of 15 feet partly excavated. This strip can easily be taken out at any future time, as it contains not more than 150 cubic yards of dirt, gravel, and a few rock bowlders. The water being very cold and deeper than to allow work even with hip boots, I saw no other way to remove the cofferdams than by the use of dynamite. Holes were bored in the center of the cofferdams to the full depth of the excavation and about 5 feet apart and charged with full cartridges of "C" Atlas powder. The 350 feet of cofferdam were loosened and blown up in three sections and all posts and timbers entirely removed by the expolsion. The dirt was loosened so that the current took all out immediately; some mud lumps that had been left were moved by the aid of pike poles, so that no traces of the cofferdams were left.

In accordance with your orders a small party was organized to remove the snags from the river. A flatboat 8 by 14 feet was built for that purpose, to carry the ropes, blocks, and other tools necessary for such work. A tripod of three posts 6

by 8 inches was built, with bolt and hook to attach blocks and tackle for lifting snags and logs. With the aid of this derrick five good-sized snags were removed below Evansville Shoals for a distance of about 1¼ miles. The sudden rise of the river stopped this work. I found this derrick to work very well for small logs and when the water is not too deep. I also used Atlas powder in loosening logs, the ordinary fuses being used, as the handling of a battery was found to be inconvenient, and as in most cases one cartridge at a time was found sufficient to loosen the log so that it could be handled by log chain and derrick.

The property and tools were all stored in the office building in charge of a special watchman, with orders to ship it all to St. Louis as soon as navigation opens. The engineering implements I brought back with me. The accompanying sketches show the locations and dimensions of the work.

Very respectfully, your obedient servant,

RICHARD KLEMM,
Assistant Engineer.

Maj. A. M. MILLER,
Corps of Engineers, U. S. A.

Commercial statistics, Kaskaskia River, Illinois, 1890, 1891.

Articles.	1890.	1891.
	Tons.	*Tons.*
Coal	60	400
Cordwood and lumber	2,105	2,054
Flour, grain, etc	5,837	9,186
Merchandise	400	405
Total	8,402	12,045

List of steam-power boats engaged in commerce on Kaskaskia River, Illinois, during the year 1891.

Name.	Length.	Breadth.	Depth.	Gross tonnage.
	Feet.	*Feet.*	*Feet.*	*Tons.*
Dolphin	135.8	22.8	4.8	156.16
Little Nick	60	10	3	14.22
Mary M. Michael	143.3	26.3	4.4	234.44
Nick Sauer	100	18	4	99.27

APPENDIX Y.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF ILLINOIS RIVER AND MINNEAPOLIS, AND OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 8, 1892.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1892.

Very respectfully, your obedient servant,

A. MACKENZIE,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Y 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work covered by this appropriation is the removal of snags, wrecks, and other obstructions, the cutting and pulling back of overhanging trees, the clearing of shores, the searching for and marking of new channels, assisting stranded boats and barges, surveys and examinations in connection with new improvements and for facilitating

navigation through bridges, inspection and repair of works, formation of temporary or permanent channels through obstructing bars, and in general in benefiting commerce by aiding existing navigation and assisting in the permanent improvement of the Upper Mississippi River.

The plant belonging to this work consists of the snag boats *General Barnard* and *J. G. Parke*, and to these are added, as occasion demands, and circumstances permit, dredges, launches, barges, etc., belonging to the general appropriations. The operations of the snag boats and dredges extend from Minneapolis to the mouth of the Missouri River, about 724 miles. At times when the snag boats are not required on work above mentioned they are used under general or special appropriations for work of permanent construction.

By the river and harbor act of August 11, 1888, provision was made for operating snag boats and dredge boats on the Upper Mississippi River under a permanent appropriation, the annual expenditure being limited by the act to $25,000. There has been expended under the permanent appropriation during the fiscal year ending June 30, 1892, the sum of $25,000.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., July 1 to July 28, August 18 to October 4, and October 26 to 31, 1891, and May 12 to 31, 1892. From July 29 to August 17, 1891, she was employed on repair and construction work in vicinity of La Crosse, and from October 5 to 25, 1891, on similar work in Crooked Slough.

During the low-water period of 1891, which was an extremely low-water year, the river reaching at many points a lower stage than in 1864, the low water of which was the lowest hitherto known, the *Barnard*, believed to be the heaviest draft boat on the river (with one exception), made a trip from St. Louis to St. Paul. On this trip many obstructing bars were met with and much trouble was experienced at unimproved portions of the river, but at points where works of improvement have been completed little or no difficulty was found. In 1864, prior to the inauguration of river improvement, navigation was almost wholly suspended, the very lightest boats being unable to reach St. Paul. In 1877 the situation was nearly as bad, although the low-water stage was in that year three-quarters of a foot higher than in 1864 and 1891. On the *Barnard's* low-water trip careful soundings were made on all the shoal bars, and numerous water surfaces were taken by leveling. The *Barnard's* levels, taken together with those of the survey and construction parties employed along the river and the gauge records of the various bridges, will afford a complete record of the low water of 1891 at all points from Minneapolis to the mouth of the Illinois River.

The snag boat *J. G. Parke*, dredge *Phœnix*, launch *Elsie*, and a number of dump boats were employed as a dredging and wrecking plant during the season of 1891, from July 1 to October 31. This plant removed three wrecks, three rock patches, deepened the channel at five different localities, and performed considerable other work in the removal of snags and impending trees.

The details of work accomplished, together with statistics of commerce and navigation, are given in the appended report of Assistant Engineer C. W. Durham.

A detailed statement and a summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892, are appended.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of Missouri River for calendar year 1891 was,

approximately, 4,200,000 tons. This includes logs and lumber, as well as ordinary merchandise.

ABSTRACT OF APPROPRIATIONS.

By act approved March 2, 1867..	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
By act approved—	
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
Total	624,640

Money statement.

June 30, 1892, amount drawn from Treasury under permanent appropriation	$25,000
June 30, 1892, amount expended during fiscal year	25,000
July 1, 1892, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1893	25,000

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	July, 1891.							
1	Pilot Steamboat Co	$75.10				$75.10		
2	Fred. A. Bill	27.00				27.00		
3	Thos. E. Schindler & Co	22.58			$22.58			
4	Chas. J. Long	10.60			10.60			
5	Ben. Wilson & Son	68.61					$4.97	$63.64
6	C. W. Durham	2.25	$2.25					
7	W. D. McManus	126.00				126.00		
8	Henry Koettker	20.00			20.00			
9	A. Boschert & Co	52.30			52.30			
10	T. Nodler	37.57			33.52		4.05	
11	Kellog Birge Co	252.31			246.31		6.00	
12	......do	33.79			33.79			
13	A. M. Riddle	16.53					16.53	
14	W. A. Bonsack Lumber Co	40.26						40.26
15	McElroy & Armitage	56.73						56.73
16	C. A. Hutchinson	8.00			8.00			
17	James Ward & Son	354.15					354.15	
18	L. T. Davis	27.00				27.00		
19	Pilot Steamboat Co	78.70				78.70		
20	Ben. Wilson & Son	12.80					12.80	
21	C. F. Alden & Co	159.24				159.24		
22	Thos. E. Schindler & Co	27.79			27.79			
23	Chas. J. Long	44.43			40.13		4.30	
24	McCabe Brothers	10.55					10.55	
25	Hired men	1,523.33		$1,523.33				
26	Various persons	36.85			15.85	21.00		
	Total	3,124.47	2.25	1,523.33	510.87	514.04	413.35	160.63

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	August, 1891.							
27	S. G. Garnett	$30.00				$30.00		
28	Andrew Warsop	35.70						$35.70
29	John P. Sommers	6.72					$6.72	
30	Robinson & Cary Co	17.38					17.38	
31	R. C. Libby & Co	17.56						17.56
32	Ewald Iron Co	106.71						106.71
33	Chas. L. Barnum	9.00				9.00		
34	Kranz & Jahn	26.32			$26.32			
35	Matt Ahern	24.55			24.55			
36	Yanz & Son	25.66			24.06		1.60	
37	S. G. Garnett	40.00				40.00		
38	James Robinson & Son	49.00				49.00		
39	S. W. Vanderwarker	134.00				134.00		
40	T. C. Bright & Co	30.00				30.00		
41	Gaunitz Bros. & Schwab	26.05			26.05			
42	R. T. Wilson	90.24			90.24			
43	J. F. Brown	26.80			26.80			
44	Mercord Bros	15.79			11.79		4.00	
45	W. D. Sutton	15.67			15.67			
46	Fred. A. Bill	28.26				28.26		
47	C. W. Durham	8.25	$8.25					
48	James Robinson & Son	45.00				45.00		
49	Ferd. Walter & Son	24.40			24.40			
50	John O'Neil	27.00				27.00		
51	McDonald Bros	75.83			74.33		1.50	
52	Chas. J. Long	15.85			15.45		.40	
53	Thos. Schindler & Co	23.24			23.24			
54	Henry Harrison	18.00				18.00		
55	W. W. Frick	18.00				18.00		
56	Hired men	1,284.83		$1,284.83				
57	....do	240.00		240.00				
58	....do	1,070.58		1,070.58				
59	Various persons	28.11			6.11	22.00		
60	C. A. Hutchinson	27.40			7.00	20.40		
61	C. Bowling	20.16				20.16		
62	Ben. Wilson & Son	36.00						36.00
63	Alex. Latshaw	24 00				24.00		
64	S. G. Garnett	20.00				20.00		
65	McDonald Bros	29.37			23.71		5.66	
66	T. Nodler	15.26			14.86		.40	
	Total	3,806.69	8.25	2,595.41	434.58	534.82	37.66	195.97
	September, 1891.							
67	Various persons	50.39			21.89	37.50		
68	McDonald Bros	6.00				6.00		
69	Wm. Harland	38.70				38.70		
70	G. A. Palmer	22.50				22.50		
71	M. Funk	67.13					2.28	64.85
72	J. F. Ris & Bro	35.00					35.00	
73	Iowa Iron Works	4.37						4.37
74	J. W. Niemer	22.33			22.33			
75	Klindt, Geiger & Co	38.15			37.07			1.08
76	R. S. Blakemore	5.54	5.54					
77	R. L. Pettibone	42.91				42.91		
78	Various persons	75.05			20.50	52.05	2.50	
79	C. W. Durham	9.25	9.25					
80	James Ward & Son	276.65					276.65	
81	Wm. D. McManus	73.50				73.50		
82	A. Boschert & Co	50.44			50.44			
83	Henry A. Koettker	21.75			21.75			
84	W. H. Langdale	143.31			131.08		12.23	
85	Wm. Harland	27.00				27.00		
86	C. A. Hutchinson	33.26			4.56	25.50	3.20	
87	A. M. Riddle	11.91					11.91	
88	T. Nodler	28.34			27.74		.60	
89	H. O. Browning	9.00				9.00		
90	L. T. Davis	27.00				27.00		
91	Chas. J. Long	31.02			27.02		4.00	
92	Thos. Schindler & Co	24.70			24.70			
93	Henry Harrison	18.00				18.00		
94	C. F. Alden	22.50				22.50		

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	September, 1891—Continued.							
95	Fisher & Co	$4.50			$4.50			
96	Geo. G. Perry & Bro	12.76			12.76			
97	Wm. Ryan & Co	40.39			40.39			
98	Bart E. Linehan	64.67			39.54		$25.13	
99	Fred. A. Bill	135.21				$135.21		
100	A. R. Knights & Co	1.50					1.50	
101	M. W. and E. Dupuis	4.06			4.06			
102	Geo. N. Machen	16.95			16.95			
103	Gaunitz Bros. & Schwab	18.89			18.89			
104	T. C. Bright & Co	30.00				30.00		
105	S. G. Garnett	25.00				25.00		
106	Hired men	1,495.00		$1,495.00				
	Total	3,073.63	$14.79	1,495.00	526.17	592.37	375.00	$70.30
	October, 1891.							
1	Hired men	1,175.33		1,175.33				
2	C. F. Alden & Co	103.20				103.20		
3	Wm. Gleason	3.00					3.00	
4	Jos. Bryant	30.10			30.10			
5	McDole & Schroeder	42.61			34.67		7.94	
6	Fred. A. Bill	31.50				31.50		
7	McDonald Bros	39.23			35.48		3.75	
8	W. S. Roosevelt & Co	33.10					33.10	
9	John Harry	28.00				28.00		
10	S. G. Garnett	40.00				40.00		
11	F. W. Luly & Son	18.35			17.85		.50	
12	Diamond Jo. Line Steamers	6.90						6.90
13	R. S. Blakemore	8.47	8.47					
14	S. W. Vanderwarker	67.10				67.10		
15	Clinton Bridge & Iron Co	8.80					8.80	
16	C. P. Disney & Son	52.85				52.85		
17	E. Rathman & Sons	20.47			20.47			
18	C. S. Hilbourn	3.57			3.57			
19	D. F. Dorrance	60.00					60.00	
20	Barnard & Leas Mfg. Co	8.40					8.40	
21	Henry Harrison	98.86				98.86		
22	Thos. E. Schindler	33.75			33.75			
23	Chas. J. Long	44.79			43.09		1.70	
24	Davis & Co	4.38					4.38	
25	Hartz & Bahnsen	5.89					5.89	
	Total	1,968.65	8.47	1,175.33	218.98	421.51	137.46	6.90
	November, 1891.							
26	Various persons	17.40			10.65	6.75		
27	......do	158.75			10.15	148.60		
28	Leicht Bros	11.97			11.22		.75	
29	Steinbrecher, Dehn & Lau	18.07			18.07			
30	H. O. Browning	51.66				51.66		
31	J. L. Vanosdoll	10.95			10.95			
32	Chas. Allen	14.30			14.30			
33	R. S. Owen	50.00				50.00		
34	T. C. Bright & Co	307.66			57.96	249.70		
35	Gaunitz Bros & Schwab	91.52			91.27		.25	
36	C. A. Hutchinson	25.50				25.50		
37	S. G. Garnett	50.00				50.00		
38	Fred A. Bill	36.00				36.00		
39	T. Nodler	10.60			8.30		2.30	
40	John Schlegel	13.90			13.90			
41	Thos. E. Schindler & Co	27.51			27.51			
42	Chas. J. Long	9.05			8.95		.10	
43	Henry Harrison	36.00				36.00		
44	William Don	2.50	2.50					
45	Hired men	1,346.00		1,346.00				
46	......do	265.00		265.00				
47	......do	1,070.00		1,070.00				
48	......do	36.00		36.00				
49	St. Louis, Keokuk and Northwestern Rwy Co	75.24					75.24	
50	......do	47.47					47.47	

iled statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892—Continued.

To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
November, 1891—Continued.							
C. A. Hutchinson	$17.00				$17.00		
L. Clinton	20.00				20.00		
C. W. Durham	7.25	$7.25					
F. R. Martin	9.50	9.50					
W. R. Tibbals	12.13	12.13					
Hired men	309.00		$309.00				
.....do	72.00		72.00				
E. Schultz	5.31					$5.31	
Totals	4,235.24	31.38	3,098.00	$283.23	691.21	131.42	
December, 1891.							
Albert Gillespie	7.33		7.33				
Hired men	415.00	200.00	215.00				
C. H. Appleton	355.33					355.33	
McElroy & Armitage	11.88						$11.88
A. Weber & Co	1.76						1.76
Total	791.30	200.00	222.33			355.33	13.64
January, 1892.							
Hired men	215.00		215.00				
February, 1892.							
Hired men	215.00		215.00				
March, 1892.							
Hired men	465.00	250.00	215.00				
Mitchell & Lynde	75.00	75.00					
Total	540.00	325.00	215.00				
April, 1892.							
C. W. Durham	9.75	9.75					
D. Tipton	18.45	18.45					
Hired men	120.83		120.83				
.....do	427.34	100.00	327.34				
Total	576.37	128.20	448.17				
May, 1892.							
Hired men	234.50		234.50				
D. Tipton	125.00		125.00				
Hired men	188.00						188.00
McElroy & Armitage	156.76						156.76
Mossman & Vollmer	18.25	18.25					
R. S. Blakemore	16.86	16.86					
St. Louis, Keokuk and Northwestern Rwy. Co	35.00					35.00	
Baker & Housman	6.90					6.90	
Chas. J. Long	22.75			19.90		2.85	
Thos. E. Schindler & Co	18.85			18.85			
Coal Valley Mining Co	72.00				72.00		
Buck Reiner Co	227.46			213.06		13.80	
Mississippi Coal and Ice Co	4.00			4.00			
J. W. Niemer	8.16			8.16			
Various persons	17.25			7.25	10.00		
E. M. Dickey Co	55.50				54.00	1.50	
Standard Oil Co	5.88					5.88	
Carson & Rand	7.32						7.32
Wilkinson & Co	51.10						51.10

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repair.
24	McElroy & Armitage	$37.01						$37.01
25	Various persons	19.75			$4.75	$15.00		
26	T. C. Bright	23.00				23.00		
27	J. W. Niemer	9.12			9.12			
28	Hired men	1,434.50	$100.00	$1,334.50				
29	Coal Valley Mining Co	108.00				108.00		
30	Kahlke & Bro	24.34						24.34
31	Thos. E. Schindler & Co	21.06			21.06			
32	T. Nodler	48.68			47.18		$1.50	
33	Chas. J. Long	17.15			15.65		1.50	
34	A. Leschen & Sons Rope Co.	32.05					22.80	9.25
35	J. A. Fay & Co	15.40						15.40
36	Hired men	251.00		251.00				
	Total	3,312.60	135.11	1,945.00	369.58	282.00	91.73	489.18
	June, 1892.							
37	Hired men	47.70						47.70
38	C. W. Durham	4.00	4.00					
39	F. H. Ketcham	93.00				93.00		
40	James Ward & Son	4.43					4.43	
41	Karle & Schulz	15.50					15.50	
42	George Hill	21.75						21.75
43	C. W. Durham	7.25	7.25					
44	Taber & Co.	1.75						1.75
45	F. H. Ketcham	159.00				159.00		
46	Karle & Schulz	2.50					2.50	
47	A. Mackenzie, major of engineers	58.64	58.64					
48	P. R. Sutton	5.70					5.70	
49	Standard Oil Co	36.96					36.96	
50	Hired men	1,460.00	200.00	1,260.00				
51	......do	340.00		340.00				
52	C. W. Durham	7.50	7.50					
53	T. Nodler	45.33			43.98		1.35	
54	Kellogg Birge Co	263.01			253.01		10.00	
55	Frank J. Weess	68.76			68.76			
56	Chas. Schultz	3.90			3.90			
57	Kellogg Birge Co	494.37					494.37	
	Total	3,141.05	277.39	1,600.00	369.65	252.00	570.81	71.20

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1892.

Month.	Office expenses, superintendence, etc.	Care, repair, and operating snag boats.					
		Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.
1891.							
July	$2.25	$1,523.33	$510.87	$514.04	$413.35	$160.63	$3,122.22
August	8.25	1,524.83	236.31	295.68	2.30	36.00	2,095.12
September	14.79	1,495.00	363.43	419.80	311.09		2,589.32
October	8.47		53.33	166.60	36.85		256.78
November	31.38	1,992.00	195.84	548.35	47.72		2,783.91
December	200.00	215.00					215.00
1892.							
January		215.00					215.00
February		215.00					215.00
March	325.00	215.00					215.00
April	128.20	448.17					448.17
May	135.11	1,694.00	369.58	282.00	91.73	332.42	2,769.73
June	277.39	1,260.00	369.65	252.00	263.81	47.70	2,193.16
Total fiscal year	1,130.84	10,797.33	2,099.01	2,478.47	1,166.85	576.75	17,118.41

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1892.—Continued.

Month.	Care, repair, and operating of dredge and tender.						Grand total.
	Labor.	Subsistence.	Fuel.	Expense.	Repairs.	Total.	
1891.							
July							$3,124.47
August	$1,070.58	$158.70	$277.71	$36.36	$159.97	$1,703.32	3,806.69
September		203.31	134.00	62.91	70.30	469.52	3,073.63
October	1,175.33	165.65	254.91	100.61	6.90	1,703.40	1,968.65
November	1,106.00	87.39	142.86	83.70		1,419.95	4,235.24
December	7.33			355.33	13.64	376.30	791.30
1892.							
January							215.00
February							215.00
March							540.00
April							576.37
May	251.00				156.76	407.76	3,312.60
June	340.00			307.00	23.50	670.50	3,141.05
Total fiscal year	3,950.24	614.05	809.48	945.91	431.07	6,750.75	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1892.

MAJOR: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1892, together with some statistics of commerce and navigation:

OPERATIONS OF SNAG BOAT GENERAL BARNARD.

The *Barnard* left Dubuque on the morning of July 1, 1891, and, proceeding down river, arrived at Keokuk on the evening of the 3d. On her way down considerable work in removing snags and impending trees was performed at Nine Mile Island, at Pomme de Terre Prairie, above Keithsburg Bridge, and in Dallas Chute.

From July 4 to 10 the *Barnard* lay at Keokuk, making repairs to capstans, taking on supplies, and refitting generally.

July 11 the snag boat left Keokuk for below, arriving at St. Louis on the 12th; and, returning up river, arrived at La Crosse on the 28th. On this trip work in removing obstructions was performed at or near Alexandria, Fabius Island, Hickory Chute, Louisiana, Clarksville Chute, Mason Chute, Hatchet Chute, Sandy Island, Turners Island, Maple Island, Sterling Island, Amaranth Island, Blackbird Island, Mundys, Marion City, Ortons Island, Oquawka, Benton Island, Elk River Slough, Dubuque, Maquoketa Slough, Yellow River, Brownsville, and Broken Arrow Island. A barge wreck at mouth of Henderson River was removed and a buoy placed on the wreck at head of Iowa Island.

From July 29 to August 17 the crew of the *Barnard* was employed in construction work in vicinity of La Crosse. The material used was paid for under appropriation for "Improving Mississippi River from Minneapolis to Des Moines Rapids," and was brought to the work by towboat *Alert* and launch *Ada*, the *Barnard* being used as quarters for the laborers. The work performed consisted in the construction of 1,115 linear feet of shore protection at left bank above Taylors Island (105); of a dam across the cut-off at Bates Island (104); and in making repairs to shore protections at Taylors Island and Grand Island (106). Further details of this work are given in my report on work of the general appropriation above mentioned. While this work was going on, water gauges were established at both of the La Crosse bridges, the one at the new bridge being cut in stone on the east draw pier.

On August 18 the *Barnard* proceeded down river from La Crosse and reached St. Louis September 3. On account of the very low stage of water considerable difficulty was experienced in getting over the bars at Deadmans, Sand Prairie, Turkey Island, Burlington, Pontoosuc, and Sterling Island. Several stranded steamboats were set afloat. A number of the proposed dams below bridge at Prairie du Chien were located. A large and dangerous rock opposite the steamboat landing at Genoa was broken up with dynamite. Snags, impending trees, and other obstructions were removed at or near Broken Arrow Island, Coon Slough, Battle Slough, Lansing, Lynxville, Wyalusing, Glenhaven, Cassville Slough, Eagle Point, Deadmans, Galena River, Bellevue Chute, Sand Prairie, Arnolds, Keithsburg, Oquawka, Sauerweins, Dallas

Chute, Des Moines River, Ortons Island, Clarksville Island, McCoys Island, and Thomas Chute.

On September 5 the *Barnard* returned up river from St. Louis and reached St. Paul on the 29th. This trip was a remarkable one, owing to the heavy draft of the *Barnard* and the extremely low stage of the river, which was, between St. Louis and Keokuk, lower than ever known before, and, above Keokuk, nearly if not quite, as low as the low water of 1864. (The low water of 1864 has hitherto been used as the datum of low water on the Upper Mississippi.) Progress was very difficult at several unimproved localities, but at points where our work has been completed very little obstruction was met with. The bars, in getting over which the greatest difficulty was experienced, were at foot of Hickory Chute, above Burlington, foot of Illinois Slough, at Sand Prairie, at Bellevue Slough, Deadmans, Eagle Point, picnic grounds above Dubuque, below Glenhaven, and below lower bridge at Winona. Numerous sunken snags, that would probably have been missed at a higher stage, were found and removed, and in this regard the work of the trip, as well as of the season, was very successful. On this trip snags, impending trees, etc., were removed at or near Jersey Landing, Mason Chute, Enterprise Island, Iowa Island, Dardenne Island, Sarah Ann Island, Sandy Island, Turners Island, Hogville, Westport Island, Thomas Chute, McCoys Island, Carrolls Island, Amaranth Island, Bayou St. Charles, Fabius Island, Ortons Island, Buzzard Island, Fox Island, Potters Slough, Sauerwein's Bend, Bay Island, and Deadmans Bar.

On October 1 the *Barnard* left St. Paul for down river, and, taking in tow four barges at Trempealeau, arrived at Lansing on the 4th. From October 5 to 15 lay at Lynxville, the crew being employed on construction work in Crooked Slough. On the 16th the *Elsie*, which had previously done the towing, having broken her shaft, the *Barnard* was brought out and towed for the work until its completion, October 24. The material used in the work at Crooked Slough was paid for under appropriation for "Improving Mississippi River from Minneapolis to Des Moines Rapids." The work consisted in the construction of 1,183 feet of shore protection and the needed repairs to various shore protections in the slough. Further details of this work are given in my report on work of the general appropriation above mentioned. On October 25 the fleet was taken to Genoa, where it was received by United States towboat *Alert*.

On October 26 the *Barnard* started down river, arrived at Keokuk on the 31st, and then laid up for winter in the Des Moines Rapids Canal. On the way down work was performed at or near Bad Axe, Lansing, Heytmans, Keithsburg, and Twin Island. The débris of the old railroad transfer at Sabula was cleared away.

In 1892 the *Barnard*, having received ordinary needed repairs, left Keokuk May 12, and proceeded up river as far as Lynxville, where she arrived at noon on the 25th. On account of high water and rising river she then turned back and ran to Keokuk. On this trip work was performed at or near Skunk River, Benton Island, Johnsons Island, Keithsburg, Iowa River, Bay Island, Pomme de Terre Prairie, Dark Slough, Kellers Island, Arnolds, Nine Mile Island, Eagle Point, Maquoketa Slough, Hurricane, Island, Jacko Island, Cassville Slough, Ferry Slough, and Clayton.

The *Barnard* was in commission during the fiscal year 145 days, 31 of which were spent on construction work near La Crosse and at Crooked Slough.

Between June 7 and 12, 1892, the *Barnard* and her crew were employed in closing a break in the Hunt Levee, near Canton, Mo. During the remainder of the month the crew were engaged in wrecking work and in making repairs.

Summary of operations of snag boat General Barnard for the fiscal year ending June 30, 1892.

Snags removed		319
Leaning trees pulled back		58
Leaning trees felled		1,095
Wreck removed		1
Steamboats assisted		7
Rock removed (Genoa)		1
Miles run		4,092
Rock put in works by crew	cubic yards..	4,444.3
Brush put in works by crew	do....	2,366.7

Débris of railroad transfer below Sabula Bridge removed, involving the cutting of 50 piles and the breaking up of 40 bowlders and pieces of rock.

OPERATIONS OF DREDGE PHŒNIX, SNAG BOAT J. G. PARKE, AND STEAM LAUNCH ELSIE.

The *Parke*, dredge *Phœnix*, and launch *Elsie* were used as a dredging plant during the season of 1891 in deepening permanent and temporary channels and in removing

wrecks and other obstructions. The *Parke* was principally used in towing the dredge and dumps from point to point. On arriving at the locality where dredging work was to be performed, the *Parke* was laid up and her crew put on launch *Elsie*, which performed the towing for the dredge.

On September 22, the *Elsie* was withdrawn for other work; and after this date until close of season the towing was done by the *Parke*.

During the month of July, 1891, the plant was engaged in deepening and widening the permanent channel opposite Nininger. Some bowlders and fragments of rock were removed from the shore along the front of the quarries above Nininger and at entrance to Boulanger Slough. Details of the above work will be found in report under head of "Improving Mississippi River from Minneapolis to Des Moines Rapids," from which appropriation this work was paid for. On July 26 the *Parke* made a trip from Hastings to Redwing and return, removing three dangerous snags from near the mouth of Cannon River.

From July 29 to August 4, dredge *Phœnix* lay at Hastings, undergoing repairs, launch *Elsie* in the mean time being employed in towing material for work between St. Paul and Prescott.

From August 5 to August 17 the dredge was employed in widening and deepening the channel below Island 21 (Wharf-boat Bar). Three cuts were made through the bar, the dredge covering an area about 950 feet long and 100 feet wide. Amount of material dredged and removed was 8,261 cubic yards; time spent in casting was four days. Had it not been for this work navigation at this locality would have been much impeded, if not entirely checked.

On August 18 the plant moved down river, arriving at La Crosse on the evening of the 23d. On the way down snags and other obstructions were removed at or near Crats Island, Zumbro River, and Blacksmith Chute. August 24 to 26, inclusive, the dredge removed barge wreck above mouth of Root River.

August 29 the dredge commenced removing sand point at Devils Elbow, in Cassville Slough. The channel at this locality was very narrow, so much so that rafts had great trouble in making the passage. After 3,600 cubic yards of material had been removed and the channel widened about 40 feet, it was thought best to move down to Four Mile Island, below Dubuque, where navigation was finding great difficulties.

Left Devils Elbow on September 4, arrived at Four Mile Island on the 7th, and commenced operations. Work at this locality was completed on September 15. A cut 2,000 feet in length was dredged to a depth of about 5 feet, and a short second cut was made at the lower end, making a good channel of about 50 feet in width. By this work navigation was greatly benefited, although later in the season, the cut becoming somewhat filled up, some difficulty, especially to rafts, was again experienced.

On September 16 the plant again moved down river. September 17 to 19 the dredge removed barge wreck above Arnolds. The plant arrived at Sabula during afternoon of September 19. The dredge commenced removal of gravel bar at guard fence above Sabula Bridge on September 21 and continued work on the bar until the evening of the 29th. Two cuts were made, each about 500 feet in length. The material taken out (4,860 cubic yards) consisted mainly of fine gravel, coarse sand, muscle shells, and mud, in so compact a mass that its removal was quite difficult. While making the first cut the dredge met with a ledge of rock, about 75 feet below the head of guard fence. The upper surface of the ledge was nearly all at a depth of 5 or 6 feet (stage 0.6 foot); but some points projected much higher, which points were broken off. A considerable portion of the gravel bar still remains and should be removed at some future time.

On September 30 moved down the river, arriving at Cordova about noon of October 1. One day was spent in attempting to remove the obstructing rocks in this locality, but with little success. On account of the hardness of the rock, drilling and blasting will probably have to be resorted to.

Passed Rock Island Rapids October 5. October 6 to 8 the dredging plant was at work on rock and gravel patch at Rock Island landing; 27 dump loads of material were removed. More work will be needed at this locality.

Left Rock Island October 9 for down river; pulled snags above Fairport, at Prairie Bird Point, opposite Huron Island, and above Burlington. October 10 to 13 the dredge removed wreck of large model barge above Burlington. October 14 and 15 dredged at foot of sewer below landing at Burlington, removing 15 boat loads. Arrived at Devils Island October 16 and began work of removing rock patch in the crossing. This work was completed October 21, resulting in the removal of 38 boat loads of fragments of rock, bowlders, sand, and gravel.

October 22, the dredge removed bowlder in the crossing above Pontoosuc; October 23 to 31, searched for reported obstructions below lower lock of canal, opposite landing at Keokuk, and above mouth of Des Moines River, without success, placed sheer boom in winter quarters, and plant was laid up in the canal.

Summary of operations of dredge Phœnix, snag boat J. G. Parke, and steam launch Elsie from July 1, 1891, to close of season.

Snags removed	40
Trees felled	170
Leaning trees pulled back	20
Steamboats assisted	3
Rock patch removed (Devils Island)	1
Rock, gravel, and bowlder patch removed	1
Channels improved	5
Wrecks removed	3
Bowlder removed	1

In 1892 the *Parke* was employed a few days in April and May in towing for construction work near Lagrange. Only a small part of her expenses were paid from the snag-boat appropriation.

Operating snag boats and dredge boats on the Upper Mississippi River—Summary of operations from 1888 to 1892, inclusive (fiscal years).

Year.	Snag boat.	Snags removed.	Leaning trees felled and removed.	Leaning trees pulled back.	Steamboats, etc., assisted.	Miles run.	Remarks.
1888	Barnard	232	853	29		5,536	In snagging commission, 56 days. Wreck removed, 1.
1889	Barnard, Parke, and dredge Phœnix.	361	1,976	58	1	6,174	Barnard in snagging commission, 123 days. Wrecks removed, 7.
1890	Bardard, Parke, and dredge Phœnix.	398	1,615	79	20	6,807	Barnard in snagging commission, 104 days. Wrecks removed, 8; cribs, 4; towhead, 1; bowlder, 1. Posts and ring bolts put in, 31.
1891	Barnard	271	2,130	69	1	4,980	In snagging commission, 103 days. Wreck removed, 1; steamboat incline removed, 1. Posts and ringbolts put in, 8.
1892	Barnard, Parke, and dredge Phœnix.	359	1,265	78	10	4,092	Barnard in snagging commission, 114 days. Wrecks removed, 3; rocks removed, 3.
Total, 1888–1892		1,621	7,839	313	32	27,589	
Total, 1868–1887		5,194	31,330	471	131	71,206	
Grand total 1868–1892		6,815	39,169	784	163	98,795	

SNAGGING BETWEEN ST. PAUL AND HASTINGS.

During the extreme low water a large number of logs, stumps, etc., were found embedded in the river bottom, which obstructions could only be successfully removed by dredging. A number of these were found between St. Paul and Hastings which interfered somewhat with navigation at very low water and hindered, in places, a proper scouring and deepening of the channel.

Just before the close of the season of navigation a private dredge, which had previously been used by the United States for work above St. Paul, was employed in removing these obstructions. Fifty-five snags were taken out at a cost of $355.33.

REMOVING WRECK OF NATRONA.

The hull of the raft boat *Natrona*, sunk in 1891 opposite wharf boat at Dubuque, about 1,000 feet from Illinois shore, was broken up by use of dynamite April 22 and 23, 1892.

RIVER NOTES.

From July, 1891, to close of season the river was very low, and points of obstruction were numerous. The packets were run with difficulty and finally were laid up on account of the impossibility of carrying freight on the water available. A bad

bar at Hickory Chute caused all boats running from St. Louis to Keokuk to go to the bank, and virtually closed navigation to all through packets.

The shoalness of the water and the narrow channels were a great impediment to raftsmen, and, although the majority of the raft boats were kept busy, it is believed that the business was conducted at a great loss. At most of the improved localities little trouble was experienced, but at many other points navigation was greatly impeded, or entirely blocked. The river between St. Paul and Prescott, where the Government works are nearly completed, remained in good shape during the season, and boats reaching Prescott had no trouble in going through to St. Paul.

In 1892 the river early in the spring was at a good boating stage, and later, in May and June, was very high. Much damage from overflow resulted between Keokuk and the Illinois River. In vicinity of St. Louis the river attained a higher stage than before known, except in 1844. The river above Keokuk was also very high, and was sufficiently so as to cause a stoppage of the rafting business at West Newton Slough, in consequence of which nearly all of the raft boats were temporarily laid up. The snag boat *Barnard* went to the bank on account of high water, and but very little work of improvement could be carried on.

I give below the available channel depths, in feet, at some of the worst bars, during the period of lowest water in 1891, as found by the snag boat *General Barnard:* Below lower bridge at Winona, 2¾; head of Dresbach Island, 3¼; foot of Dresbach Island, 3¼; below Dakota, 3; Grand Crossing, 3¼; above Brownsville, 3¼; Valley Crossing, 3½; Cassville Slough, 3; below Gordons Ferry, 3½; Picnic Grounds above Dubuque, 2¾; Eagle Point, 3¼; Four-Mile Island, 3; Nine-Mile Island, 3½; Deadmans, 3; foot of Bellevue Slough, 3; below Bellevue, 3½; Sand Prairie, 3; Arnolds, 3¼; above Lyons, 3¼; head of Hershey Boom, 3½; foot of Illinois Slough, 3; below Keithsburg, 3¼; above Burlington, 2¾; head of Dallas Chute, 3½; above Warsaw, 3; Lone Tree, 3¼; Whitneys, 3¼; opposite Saverton, 3½; foot of Hickory Chute, 2½; Tisdales, 3½; above Becks Landing, 3¼.

NARRATIVE OF TRIP OF SNAG BOAT GENERAL BARNARD FROM ST. LOUIS TO ST. PAUL DURING THE LOW WATER OF 1891.

The low water of 1891 was a remarkable one, lower than that of 1864 (which was the lowest on record prior to 1891), from Keokuk to the Illinois River, at the head of the Des Moines Rapids, and at the head of Rock Island Rapids; and nearly, if not quite, as low from Keokuk to St. Paul. During the low water of 1877 (0.75 foot above low water of 1864) bench-marks were established and water surfaces were taken at very numerous points, from which data, there being in existence several reliable low-water marks of 1864, we were able to make a close estimate of the elevation of extreme low water at any point between the Illinois River and St. Paul. The low water of 1891 proved our calculations to be, in most cases, very nearly correct.

As regards the low water of 1864, it may be said navigation was almost wholly suspended, the very lightest boats being unable to reach St. Paul. In 1877 the situation was nearly as bad, there being but very few boats which tried to run.

The *General Barnard* is a side-wheel boat, 210 feet long, 36 feet beam, and draft 3 feet 3 inches. Her draft, light, is perhaps greater than that of any other boat (with one exception) running on the Mississippi River above the mouth of the Illinois River.

The *Barnard* left St. Louis September 5, and, on her upward journey, performed her customary work of removing snags and other obstructions, and also took, at frequent intervals, by leveling, the elevation of water surface, for future use and reference.

No very shoal water was found and no trouble was experienced until the foot of Hickory Chute was reached September 9.

Between St. Louis and Hickory Chute the following depths were found at the bars and shoal crossings: At Piasa Dam, 4 feet; Eagle Island, 5 feet; Enterprise Island, 4 feet; above Becks Landing, 3¼ feet; Sandy Island, 4 feet; Maple Island, 4 feet; Tisdales Towhead, 3½ feet; below Clarksville, 4 feet. At Louisiana Bridge, September 9, the gauge read 0.25 foot.

When we reached the foot of Hickory Chute we found a "no thoroughfare." Sounding three consecutive days, I could find but from 28 to 30 inches of water over the bar. On the third day, determined to make an effort, the *Barnard* started into the bar and, by the aid of very powerful sparring machinery, succeeded, after six hours' hard work, in getting through. This was quite a triumph for the spars. I must say in regard to this bar, that it was the worst below Keokuk; that it was so bad, some two months before, that the *Gem City* had to be taken off and the *Sidney*, a very light boat, substituted for the St. Louis and Keokuk trade; that for

three weeks prior to the *Barnard's* arrival, the *Sidney* had been unable to run; that the *Libbie Conger* had been below the bar a week, unable to get over, and that nearly every boat with raft had, for some time, experienced great difficulty in making the passage.

The *Barnard* reached Keokuk, without further trouble, on September 15. The depths on the worst bars from Louisiana to Keokuk were as follows: Foot of Hickory Chute, 2½ feet; Saverton, 4½ feet; Whitneys, 4 feet; Fabius Island, 5 feet; Lone Tree, 3½ feet; Lagrange, 4 feet; Buzzard Island, 4 feet; mouth of Des Moines River, 3½ feet.

We found the gauge at Hannibal Bridge to read 0.5 foot. At Quincy Bridge the gauge read 0.5 foot. At Keokuk, Lower Lock, the gauge read 0.0 foot (the same as low water of 1864).

Leaving Keokuk September 16, the *Barnard* arrived at Rock Island September 18. At Burlington, although we found 3½ feet, it being lumpy, and the boat getting somewhat out of the channel, we had to spar two hours to get over. One hour was spent in sparring at foot of Illinois Chute. Aside from these delays no trouble was experienced. Soundings on worst bars were: Devils Island, 4 feet; Pontoosuc, 4 feet; head of Dallas Chute, 3½ feet; foot of Shokokon, 4½ feet; above Burlington, 3½ feet; below Keithsburg, 3½ feet; Turkey Island, 4 feet; foot of Illinois Chute, 3 feet; Hershey Chute, 4 feet; opposite Buffalo, 4 feet; below Credit Island, 3½ feet. Rocks were felt at Montpelier and at several points near Horse Island. Gauge at Fort Madison Bridge showed 0.3 foot above low water of 1864, and gauge at Keithsburg Bridge showed 0.35 foot above low water of 1864.

On the 21st of September, with Rock Island Bridge guage showing 0.25 foot, we started up on the rapids. We had been told by pilots and others that it was impossible for the *Barnard* to go over the upper rapids; but we passed them with very little difficulty; in fact, we would have had no trouble but for an accident at Smiths Chain, where we got out of the channel and on the rocks, from which we extricated ourselves after 3 hours' delay. Stage at Leclaire (head of Rock Island Rapids) was 0.0 foot.

Reached Lacrosse September 26. Between Leclaire and Lacrosse we met with the following delays: 2 hours at Sand Prairie, sparring; foot of Bellevue Slough, ½ hour; Deadmans, 1 hour; at Picnic Grounds above Dubuque, 3½ hours; and below Glenhaven, 2 hours.

Soundings on bad bars gave: Above Lyons, 3½ feet; Arnolds, 3½ feet; Sand Prairie, 3 feet; foot of Bellevue Slough, 3 feet; mouth of Galena River, 4 feet; below Gordons, 3½ feet; Deadmans, 3 feet; Ninemile Island, 3½ feet; Fourmile Island, 4 feet; Picnic Grounds, 2¾ feet; Spechts Ferry, 4 feet; Finleys, 3¾ feet; Cassville Slough (foot), 4½ feet; Cassville Slough (below Glenhaven), 3 feet; Valley Crossing, 3½ feet; Crooked Slough, 5 feet; below Victory, 4 feet; below Bad Axe, 4 feet; above Brownsville, 3½ feet; Picayune Island, 4 feet; below Root River, 4 feet; and Grand Crossing, 3½ feet.

Gauges and levels showed the following stages above 1864: Clinton, 0.25 foot; Sabula, 0.0 foot; Dubuque, 0.1 foot; Bunker Chute, 0.0 foot; Glenhaven, 0.1 foot; Clayton, 0.5 foot (probable error); Prairie du Chien, 0.1 foot; Lansing, 0.4 foot; Lacrosse (lower bridge), 0.3 foot; Lacrosse (upper bridge), 0.45 foot.

The *Barnard* reached Prescott on the 28th and found no difficulty, except three-quarters of an hour's delay below the new Winona bridge, at which locality, although the water was very shoal (2¾ feet), less trouble was met with than anticipated, as the sand bottom was soft and moving and the reef short.

Soundings on the worst bars gave: Below Dresbach Island, 3½ feet; head of Dresbach Island, 3½ feet; below Dakota, 4 feet; Queens Bluff, 4 feet; Richmond, 3½ feet; La Moille, 4 feet; Mount Trempealeau, 3¾ feet; below Winona, 2¾ feet; Mount Vernon, 4 feet; West Newton, 5 feet; opposite Alma, 3½ feet; Beef Slough Boom, 5 feet; Teepeeota, 4½ feet; below Crats Island, 4½ feet; foot of Prescott Island, 4 feet.

Gauges read: At Winona, 0.4 foot; at Redwing, 0.3 foot.

On the 29th the *Barnard* ran from Prescott to St. Paul in about seven hours, the gauge at Hastings Bridge showing 0.6 foot, and the St. Paul United States Engineer Gauge showing 1.1 feet. All the crossings and bars were sounded, but none gave less than 4 feet.

In conclusion, I would say that of the many bars above Keokuk at which Government work has been done but three gave less than 4 feet at this low water, viz: below Keithsburg, above Burlington, and below Winona. At the two former places work is now going on; at the latter the trouble is due to a movement of sand, caused partly by building of new bridge, and is only temporary. Doubtless before another season is over, these places will fall into line among the improved bars.

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber

trade, which gave employment in 1891 to about 100 raft boats, valued at $750,000. Between St. Paul and St. Louis 74 saw mills were operated by 61 wholesale lumber firms, having an invested capital of about $35,000,000. Their manufactures in 1891 were: Lumber, 1,261,941,000 feet B. M.; shingles, 545,887,500. In addition to the manufacturers, there are large numbers of retail or distributing firms scattered along the river. On account of very low water prevalent during a great part of the season, the amount of the business done by the raft boats was much curtailed, as also the rafting of logs from Minneapolis down river.

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, the Joy Lumber Line, and the St. Louis, St. Paul and Minneapolis Packet Company. There are also many independent boats carrying freight and passengers. During season of 1891 the amount of freight and number of passengers carried on boats and barges could not be accurately ascertained; but partial reports gave 149,000 tons of freight and 90,770 passengers, not including those of ferry and excursion boats. This small showing was due to the extreme low water prevalent during the season. Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1891 was approximately, 4,200,000 tons.

In United States census reports of 1890, we find the following for the Upper Mississippi River, not including its tributaries:

	Number.	Tonnage.	Value.
Steamers	188	24,978	$1,485,369
Barges	285	165,685	214,018
Total	473	190,663	1,699,387

Passengers carried, regular and excursion	285,676
Passengers carried, ferry	1,192,409
Total	1,478,085
Freight moved, tons	4,486,421
Miles traveled by steamers	1,101,990
Gross earnings	$1,994,786
Expenses	$1,403,746
Net earnings	$591,040

Receipts of lumber, logs, etc., at St. Louis, from Upper Mississippi River, during 1888, 1889, 1890, and 1891.

Years.	Whitepine lumber.	Cottonwood lumber.	Total lumber.	Shingles.	Lath.	Pickets.	Total pieces shingles, lath, and pickets.
	Feet.	*Feet.*	*Feet.*	*Number.*	*Number.*	*Number.*	*Number.*
1891	80,241,799	11,109,655	91,351,454	41,037,750	20,231,050	1,114,490	62,383,290
1890	71,739,010	15,586,800	87,325,810	45,449,150	16,336,650	603,688	62,389,488
1889	71,935,820	11,951,345	83,887,165	43,350,500	21,386,350	401,932	65,138,782
1888	79,311,387	8,734,000	88,045,387	25,743,500	14,650,367	273,744	40,667,611

Statement of distribution of lumber manufacture along the Upper Mississippi River from Minneapolis to St. Louis in 1891.

Locality.	Lumber.	Shingles.	Locality.	Lumber.	Shingles.
	Feet, B. M.	*Number.*		*Feet, B. M.*	*Number.*
Minneapolis	447, 713, 000	207, 221, 000	Camanche	6, 000, 000	2, 176, 500
Hastings	6, 000, 000	[illegible], 000, 000	Moline	30, 500, 000	3, 000, 000
Red Wing	6, 000, 000	3, 500, 000	Davenport	54, 036, 000	9, 090, 000
Alma	500, 000	600, 000	Rock Island	87, 500, 000	19, 691, 000
Winona	119, 284, 000	79, 202, 500	Muscatine	51, 500, 000	40, 000, 000
Lansing	13, 300, 000	8, 000, 000	Burlington	23, 000, 000	6, 000, 000
Prairie du Chien	8, 000, 000	3, 000, 000	Fort Madison	30, 000, 000	9, 700, 000
Guttenberg	13, 650, 000	4, 000, 000	Keokuk	14, 000. 000	7, 000, 000
Dubuque	79, 000, 000	42, 000, 000	Canton	5, 070, 000	5, 878, 000
Bellevue	4, 000, 000	1, 374, 000	Quincy	22, 000, 000	8, 000, 000
Lyons	55, 000, 000	14, 924, 000	Hannibal	22, 000, 000	9, 500, 000
Clinton	149, 388, 000	50, 530, 500			
Fulton	14, 500, 000	6, 500, 000	Total	1, 261, 941, 000	545, 887, 500

Statement of amount of freight received and shipped from St. Louis by the Upper Mississippi River for five years.

St. Louis.	1891.	1890.	1889.	1888.	1887.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received	90, 865	128, 960	113, 805	114, 940	132, 400
Shipped	18, 630	22, 547	47, 560	50, 315	36, 170
Total	*109, 495	151, 507	160, 865	165, 255	168, 570

* Transportation of freight was suspended during a large part of the season on account of low water.

Arrivals and departures at St. Louis during 1891.

Steamboats and barges from Upper Mississippi River arrived at St. Louis...... 713
Steamboats and barges departed from St. Louis for Upper Mississippi River 694

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

Statement of steamers, barges, and rafts passing various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1891.	1890.	1889.	1891.	1890.	1889.	1891.	1890.	1889.
Hastings	503	454	769	510	341	590	43	45	72
Winona	3, 687	5, 417	4, 419	1, 108	1, 045	1, 140	1, 495	2, 123	1, 577
Lacrosse	3, 547	4, 738	5, 144	568	626	513	1, 265	1, 926	1, 387
Dubuque	2, 649	3, 479	3, 221	1, 190	1, 418	1, 149	*585	*860	*666
Sabula	2, 844	3, 244	2, 457	613	1, 275	1, 118	*20	1, 547	1, 158
Clinton	2, 821	3, 034	2, 592	622	662	531	*602	*538	*653
Rock Island	2, 694	3, 122	2, 607	571	650	244	634	843	725
Burlington	1, 620	1, 750	1, 634	751	767	799	411	317	268
Keokuk	1, 209	1, 597	1, 717	420	635	760	165	205	199
Quincy	1, 604	1, 956	1, 899	615	807	636	180	278	249
Hannibal	1, 637	1, 941	1, 999	590	453	547	319	500	451
Louisiana	944	989	1, 074	590	408	422	66	103	77

* Partial record.

Internal revenue for the year ending December 31, 1891.

District.	Office.	Amount.
Minnesota	St. Paul	$2,654,380.00
Second Wisconsin	Madison	476,816.96
Third Iowa	Sioux City	174,244.18
Fourth Iowa	Burlington	294,140.67
Fifth Illinois	Peoria	20,966,606.91
Aggregate		24,566,188.74

Customs revenue and tonnage for the year ending December 31, 1891.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Louis, Mo	*$1,316,311.42	7,912.05	33
Burlington, Iowa		1,039.07	11
Rock Island, Ill		5,759.86	52
Dubuque, Iowa	10,104.12	5,697.31	23
Galena, Ill	2.49	264.94	5
Lacrosse, Wis		4,707.63	58
St. Paul, Minn	295,144.89	2,292.59	31
Total	1,621,562.92	27,673.45	213

* Only a part of the St. Louis statement of collections applicable to the Upper Mississippi River.

List of wrecks between St. Louis and St. Paul which have been, are, or may become obstructions to navigation, with approximate dates of sinking, localities, etc.

When sunk.	Names.	Localities.	Remarks.
1870	A. J. Baker	Abreast of Gabaree Island. One mile above foot and 1,200 feet out from island.	May become an obstruction.
1849	Altona	In bar at Montgomerys Towhead	Lies on rock bottom, and, if towhead washes away, will be in the way of navigation.
1859	Baltimore	do	Same as for Altona.
1855	Badger State	Lying under wreck of Baltimore	Do.
1855	Cornelia	Below chain of rocks	In deep water.
1844	Unknown	About halfway between Wilsons Island and Rhodes Point.	May be in the way in the future.
1883	Barge	In crossing below Madison	An obstruction at present.
1852	America	Opposite Madison	Now imbedded in river bank.
1854	Reindeer	Below mouth of Wood River	In deep water when sunk.
1869	Barge	At mouth of Wood River	Sunk close to bank.
1852	Unknown	Foot of Maple Island	Now in sand bar.
1868	do	Foot of Alton Island	In deep water; makes a strong "break."
1880	Two barges	Abreast of Alton Island, just below cut-off.	Are now obstructions.
	Flat boat	Foot of Piasa Chute	An obstruction at low water.
	Barge	In Piasa Chute	An obstruction.
1870	do	Below Jersey Landing	In deep water; makes a strong "break."
1856	Heilman	Halfway between Missouri Point and second ravine below Grafton.	May possibly become an obstruction.
	Unknown	Foot of Masons Island, opposite Grafton.	Supposed to be a wreck; struck by Charlotte Boeckeler and other boats.
1842	Archer	In chute between Islands 521 and 522.	Removed by U. S. dredge Phœnix.
1880	Chapman	In chute between Islands 521 and 522, near Island 522.	May soon become an obstruction.
1843	Enterprise	Above head of Enterprise Island	In deep water.
1883	Barge	Above head of Iowa Island	A bad obstruction; partly removed by U. S. dredge Phœnix.
1844	Iowa	Near head of Iowa Island	
1880	Golden Eagle	In chute opposite Martins Landing	May become an obstruction.
1881	Unknown	Near shore above Hastings, Ill	Out of the way.
1841	Sarah Ann	Lying above head of Island 500	Do.
1849	Barge	Between foot of Turners Island and head of Sandy Island.	In the way at low water.

List of wrecks between St. Louis and St. Paul, etc.—Continued.

When sunk.	Names.	Localities.	Remarks.
1874	Mollie McPike	Carrolls Field, opposite Turners Landing.	Partly removed by U. S. dredge Phœnix.
1870	Little Eagle	Near and above head of Stag Island	In deep water
1842	Highland Mary	Below foot of Thomas Chute	Removed by U. S. dredge Phœnix.
1842	Barge	Near shore below Mosiers	Near shore.
1842	Amaranth	Head of Amaranth Island	May become an obstruction.
1842	Two barges	......do	
	Ferryboat	In bar opposite Island 465	
1880	Barge	At bank at slaughterhouse below Clarksville.	Near shore.
1874	Unknown	Opposite creek above Clarksville, in midstream.	May become an obstruction.
1859	Mohawk	Head of Clarksville Island	May be in the way.
1855	Hannibal City	Foot of Brokau Chute	Not likely to become an obstruction
	Flatboat	Opposite Scotts Landing	Not now in the way.
1840	Atlas	Near head of Atlas Island	Chute closed.
1840	Denmark	......do	Do.
1840	Lynx	......do	Do.
1855	Dubuque	Above Mundys Landing	Liable to become a dangerous obstruction.
	Unknown	Near head of Glasscock Island	
1874	Dictator	Opposite Hannibal	May become an obstruction at low water.
1885	Eagle	At Hannibal Bridge	In very deep water.
1856	Wm. H. Denny	Opposite head of Fabius Island, Illinois side.	Now in dry bar near shore.
	Barge	Below head of Fabius Island, Missouri side.	May become an obstruction.
1872	Palmer	Below Quincy Bridge	In deep water.
1860	Lucy May	About 5 miles below Lagrange	In the way.
1849	Brownsville	Brownsville Chute	In deep water.
1850	Ferryboat	Bludsoes Crossing	Very much in the way at the present time.
1880	S. S. Merrill	At Warsaw	Broken up and removed.
	Barge	Opposite lower sawmill at Keokuk	Can be hit at very low water.
1872	Gypsey	Opposite steamboat landing at Keokuk.	Partly removed by U. S. dredge Ajax, remainder in deep water.
1881	Wyman X	Below Fort Madison	Removed by U. S. dredge Phœnix.
	Barge	Near head of Lead Island	In bar.
	....do	At Sauerweins Point	May be in the way soon.
1885	Grand Pacific	Below Burlington Bridge	Removed by U. S. snag boat General Barnard.
1888	Barge	Above Illinois Point, above Burlington.	Removed by U. S. dredge Phœnix.
	Flatboats	Near mouth of Henderson River	Partly removed by U. S. snag boat General Barnard; will not become obstructions.
1853	Barge	Foot of Oquawka Chute	In dry bar.
	Unknown	Below Benton Island	
1852	Prairie Bird	Above Keithsburg	Removed by United States dredge.
	Flatboat	Near landing at Port Louisa	Near shore.
	....do	Above foot of island below Buffalo	In bar; somewhat in the way.
1860	Grey Eagle	Below old Rock Island bridge	Removed.
1858	Effie Afton	At old Rock Island bridge	Can not become an obstruction.
1852	J. M. Mason	Above Duck Creek Chain, Rock Island Rapids.	Will never be in the way.
	Barge	Above Duck Creek Chain, Rock Island Rapids, on Illinois side of channel.	Can not become an obstruction.
1852	Danube	Below Campbells Chain, Rock Island Rapids.	Not in the way.
	Barge	Below Smiths Chain, Rock Island Rapids, in raft channel.	In deep water.
	....do	Near shore, 3 miles above Cordova	Not in the way.
	....do	Below bridge at Clinton	In the way at low water.
1886	....do	Opposite Arnolds	Removed by U. S. dredge Phœnix.
1858	Royal Arch	Opposite Ninemile Island	Do.
1891	Natrona	Below landing at East Dubuque	Removed in 1892.
1889	Diamond Jo	At Wisconsin State line	Removed by U. S. dredge Phœnix.
	Barge	One mile above Eagle Point	Not in the way.
1854	Dr. Franklin	Foot of Maquoketa Chute	Will soon be in the way.
1871	Hudson	One mile below Guttenberg	In the way at low water.
	Barge	In bar above Clayton	Not now in the way.
1854	Nominee	Below Britts Landing	Removed by U. S. dredge Phœnix.
1856	Lady Franklin	......do	In the way at low water.
1865	Northern Light	Coon Slough	Removed by U. S. snag boat Montana.
1859	Barge	Below head of Coon Slough	In the way at low water.
	....do	Above Brownsville	Removed by U. S. dredge Phœnix.

List of wrecks between St. Louis and St. Paul, etc.—Concluded.

When sunk.	Names.	Localities.	Remarks.
1859	Three barges	Below Picayune Chute	Partly removed.
	Barge	Head of Picayune Island	Not in the way at present.
1875	Chas. Rogers	Mouth of Root River	Not in the way.
	Barge	Above Root River	Removed by U. S. dredge Phœnix.
1875	....do	Below Lacrosse	Do.
1857	Ben Corson	Above River Junction above Lacrosse.	Close to shore.
	G. H. Wilson	Opposite Dakota	In deep water.
1849	Argo	At Argo Island	Removed.
1891	Barge	Near United States light at Richtmans.	In the way.
1853	West Newton	Foot of West Newton Island	Can not become an obstruction.
1891	Barge	Opposite Wabasha	Not in the way.
1891	Ponton	Above Wabasha	Very much in the way.
1891	Barge	......do	Do.
	....do	At the mouth of Big River	Not in the way.
1857	Ferryboat	Below Prescott	Do.
1860	Fannie Harris	Below Hastings	Removed.
1856	H. T. Yeatman	......do	Do.
	Barge	Below Newport	One end in the way.
	Rumsey	Opposite St. Paul	Removed.

Locations of rocks between St. Louis and St Paul which are or may become obstructions to navigation.

In Sawyer Bend.
At and below the Chain above St. Louis.
In Piasa Chute, above and below Piasa River, and at head of chute.
Piasa Dam.
Below Salt River.
In channel opposite foot of Island 420.
Below Lagrange.
Near shore above Lagrange.
In crossing at Gregorys Landing.
Below Des Moines Rapids Canal, near sheer boom.
In draw of Keokuk Bridge, near west abutment.
At Des Moines Rapids.
Above Nauvoo, in the crossing at Devils Island.
Rock bottom above Nauvoo Landing.
At Pontoosuc and foot of Dallas Chute.
In main river opposite and below Dallas.
Above Burlington, at Drews Prairie.
On head of Otter Island and above.
At mouth of Edwards River, near shore.
At and below Oquawka.
Below New Boston, extending from Illinois shore.
Below Keithsburg, in main river and at foot of chute.
Above Muscatine.
At Fairport.
At Montpelier.
First island below Buffalo.
Near shore at Buffalo.
Near shore above Spinneyville.
At and near the head of Smiths Island.
At Horse Island, above and opposite.
At Rock Island Rapids.
In crossing below Cordova.
Above Reads, at foot of Lake Pepin.
Bowlder reef below Diamond Bluff.
Below Grey Cloud Landing.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN DES MOINES RAPIDS AND MOUTH OF ILLINOIS RIVER.

The charge of operations in this district was temporarily transferred to me by Maj. E. H. Ruffner, Corps of Engineers, U. S. Army, January 16, 1892, and from the office records the following report for the first half of the fiscal year is prepared:

OPERATIONS FROM JULY 1 TO DECEMBER 31, 1891.

The portion of the season of 1891 covered by this report was exceedingly unfavorable to work, the water being extremely low, in certain

localities about 6 inches lower than ever before known. This low-water made the towing of material more expensive and difficult, and also greatly increased the expense of putting it in position. The principal obstruction to navigation was at the foot of Hickory Chute. This locality, at which the channel had been very shallow during earlier part of season, finally put a stop, for a time, to all navigation. Some trouble was also, for a short time, experienced near the mouth of the Des Moines River. The remainder of the river was, considering the low stage of water, in fair condition.

QUINCY BAY.

The work of dredging in Quincy Bay was continued under contract with Mr. H. S. Brown, the price for removing material being 12.4 cents per cubic yard. Mr. Brown completed his contract October 30, 1891, having removed 48,200.5 cubic yards between July 1 and that date. The total amount removed under his contract was 82,964 cubic yards. The bay at the close of the season was in good condition, there being ample depth for all purposes of navigation, and there was also a deep, though narrow, channel through Cedar Creek Bar.

CLARKSVILLE HARBOR, MISSOURI.

The towboat *Success* and fleet were employed until July 26, 1891, in raising and strengthening the closing dam extending from the head of Clarksville Island to the Illinois shore. Work was suspended on account of low water. The dam is about 1,800 feet long and has its crest at an elevation of about 4 feet above low water. It is built chiefly of dredged material and contains 35,817 cubic yards of gravel, 2,927 cubic yards of rock, and 2,432 cubic yards of brush.

SNY ISLAND LEVEE.

Some slight repairs were made to the shore protection near Scotts Landing, built to secure the Sny Levee. Payments were made for material used prior to July 1, 1891.

COTTONWOOD ISLAND REACH.

The towboat *Coal Bluff* and barges completed, in July, 1891, the shore protection on Missouri shore opposite foot of Hog-back Island (422). The total length of this shore protection is 3,600 feet. The amount of material put in during July, 1891, was, of rock, 2,749.6 cubic yards, and, of brush, 527.3 cubic yards.

HICKORY CHUTE.

During July and up to August 16, 1891, the towboat *Success* and barges were employed in the construction of the upper wing dam, 600 feet long, running out from Missouri shore at foot of Hickory Chute. One thousand eight hundred cubic yards of rock and 871 cubic yards of brush were put in this dam. The fleet was laid up August 16 on account of difficulty in obtaining rock. In September, 1891, the condition of the bar was so bad that further work was undertaken. A low, light wing dam was built from head of Angle Island (456) across to the dry bar and from the dry bar out into the river. In all, 1,430

linear feet of dams and bar were utilized. This work was carried out between September 19 and October 4, 1891, and consumed 1,252.5 cubic yards of rock and 1,921.6 cubic yards of brush.

TULLY ISLAND.

On July 16, 1891, towboat *Coal Bluff* and barges commenced operations in vicinity of Tully Island. The first work accomplished was the construction of a wing dam 925 feet in length and extending from the Illinois shore. This dam, the farthest down stream of the projected series, was completed August 5 and contains 2,757.4 cubic yards of rock and 1,362.1 cubic yards of brush. Work was then begun on the closing dam from the head of Tully Island to the Missouri shore. This dam, together with shore protection on head and east side of Tully Island, was completed September 19, 1891, on which date operations in this vicinity were discontinued. The closing dam, 1,300 feet long, and shore protection, 1,000 feet long, contain 5,379.9 cubic yards of rock and 2,907 cubic yards of brush. An additional 600 feet of shore protection were also built on east side of Tully Island with 759.1 cubic yards of rock brought by the *Coal Bluff* and 1,314.3 cubic yards of gravel furnished by United States dredge No. 2.

OPERATING DREDGE NO. 2.

Shore protection above Hannibal Bridge.—The Illinois shore, from a point about one-half mile above Hannibal Bridge, was protected for a distance of 1,800 feet by the deposit of gravel from dump boats. The gravel, which was of a very coarse and excellent quality, principally spalls, was obtained by Dredge No. 2 from the Missouri shore opposite and taken on dump boats by steam launch *Iris* to the Illinois side. The dredge was also employed several days in casting the surplus material farther up the bank. Eight thousand eight hundred and fifty-three cubic yards of gravel were put in the work.

Shore protection at head of Tully Island.—Dredge No. 2 and launch *Iris* furnished gravel for use in about 600 linear feet of shore protection at Tully Island. A quantity of rock was also used in this protection. A part of the gravel was obtained from a gravel bar opposite Canton and the remainder from Wyaconda Bar. Amount of gravel used in this work was 1,836 cubic yards. The work at the two points above mentioned was performed in July and August, 1891.

There were obtained and put in at these points 10,689 cubic yards of gravel, at a total cost (exclusive of superintendence, office, and plant charges) of \$2,725.93, an average cost of 25.5 cents per cubic yard.

CARE AND MAINTENANCE OF PLANT.

All the fleet was laid up in Quincy Bay at close of operations. Only minor repairs and those incidental to operating were made.

A list of works constructed and of materials used from July 1, 1891, to December 31, 1891, between Des Moines Rapids and the mouth of the Illinois River.

Designation.	Length.	Material.		
		Rock.	Brush.	Gravel.
Sheet 65:	*Lin. ft.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Wing dam, Illinois side	925	2,757.4	1,362.1	....
Closing dam, Tully Island to Missouri shore	1,300	6,139	2,907	1,836
Shore protection on Tully Island, head and east side	1,600			
Sheet 67:				
Shore protection on Missouri shore opposite Island 422	1,375	2,749.6	527.8	....
Sheet 70:				
Shore protection in bend on Illinois shore above Hannibal Bridge	....	....	....	8,853
Sheet 74:				
Upper wing dam, foot of Hickory Chute	600	1,800	871	....
Lower wing dam, foot of Hickory Chute	1,430	1,252.5	1,921.6	....
Sheet 76:				
Closing dam 1, from Clarksville Island to Missouri shore (part)	1,800	2,926.9	2,431.8	....
Total	....	17,625.4	10,020.8	10,689

Financial statement.

Amount expended in the field from July 1, 1891, to December 31, 1891 (exclusive of general superintendence, office expenses, and charge for use and deterioration of plant), for rock and brush work	$30,555.63
Materials put in works:	
Rock ... cubic yards	17,625.4
Brush ... do	10,020.8
Total ... do	27,646.2
Average cost per cubic yard of rock and brush work in place (field expenses)	$1.105
Amount expended in the field from July 1, 1891, to December 31, 1891, (exclusive of general superintendence, office expenses, and charge for use and deterioration of plant), for putting gravel in shore protection	$2,725.93
Number of cubic yards of gravel put in shore protection	10,689
Average cost per cubic yard of gravel put in shore protection (field expenses)	$0.255

Summary of expenditures from July 1 to December 31, 1891, inclusive.

Quincy Bay	$10,188.25
Clarksville Harbor, Missouri	7,714.16
Sny Island Levee	2,755.50
Cottonwood Island Reach	8,378.28
Hickory Chute	6,451.69
Tully Island	11,735.32
Operating dredge No. 2	2,725.93
Care and maintenance of plant	1,228.22
Superintendence and office expenses	644.41
Total	51,821.76

OPERATIONS FROM JANUARY 1 TO JUNE 30, 1892.

A project for the expenditure of $165,000, appropriated by the river and harbor act of September 19, 1890, for "improving Mississippi River from Des Moines Rapids to the mouth of the Illinois River," was submitted by Maj. E. H. Ruffner, Corps of Engineers, U. S. Army, September 24, 1890, and approved by the Chief of Engineers, October 23, 1890. This project was followed during the season of 1891.

Under date of January 5, 1892, in forwarding for action certain proposals for furnishing rock and brush, Maj. Ruffner presented a propo-

sition for using such material and exhausting the balance of appropriation available in the repair of existing works at various points along the river.

In September, 1891, and January, 1892, formal contracts were entered into by Maj. Ruffner for the furnishing on barges, at various points, 41,389 cubic yards of rock and 15,000 cubic yards of brush.

At the date of the transfer of this work to me (January 16, 1892), there was an unexpended balance of appropriation of $69,009.55; of this amount $11,992.05 was applicable to dredging in Quincy Bay and $30,321.96 assigned to purchase of material under formal contract, leaving $26,695.54 available for contingent expenses, repairs and care of plant, purchase of additional brush, and for putting in place the material contracted for.

In his last annual report Maj. Ruffner recommended that so much of the balance reserved for dredging Quincy Bay as may be necessary be used for constructing a retaining levee on Whipple Creek Bar, to hold the material dredged from the bay. No further work under the allotment for dredging Quincy Bay can be done until the action of Congress on such recommendation is determined.

In April, 1892, a survey of the river in vicinity of the mouth of the Des Moines River was made, and plans for channel improvement were prepared.

Construction work was commenced April 22, 1892; but on May 6 operations were discontinued on account of high water. The work accomplished was the repair of Smoot Chute and Oyster Island closing dams (Nos. 2 and 5, sheet 66). Two thousand and ninety-three and nine-tenths cubic yards of rock and 902.6 cubic yards of brush were put in these dams. The river still remains too high for the construction of dams and the protection of shores.

Statistics of commerce and navigation applicable to this portion of the river may be found under the head of "operating snag boats and dredge boats on Upper Mississippi River."

The work herein referred to was in local charge of Mr. A. L. Richards, assistant engineer, from whose report details are taken.

Abstract of appropriations.

By act approved—	
June 18, 1878	$100,000
March 3, 1879	40,000
June 14, 1880	100,000
March 3, 1881	175,000
By act passed August 2, 1882	200,000
By act approved July 5, 1884	200,000
By act approved August 5, 1886	$150,000
By act of August 11, 1888	200,000
By act of September 19, 1890	165,000
Total	1,330,000

Money statement.

July 1, 1891, balance unexpended		$121,340.91
June 30, 1892, miscellaneous receipts		64.20
		121,405.11
June 30, 1892, amount expended during fiscal year		60,541.35
July 1, 1892, balance unexpended		60,863.76
July 1, 1892, outstanding liabilities	$153.82	
July 1, 1892, amount covered by uncompleted contracts	28,783.72	
		28,937.54
July 1, 1892, balance available*		31,926.22

* An appropriation of $600,000 for improving Mississippi River between mouth of the Missouri River and Minneapolis was made by the river and harbor act approved July 13, 1892.

Amount (estimated) required for completion of existing project	Unknown
Amount that can be profitably expended in fiscal year ending June 30, 1894	$500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for electric-light plant for United States towboat Coal Bluff opened at Quincy, Ill., by Maj. E. H. Ruffner, Corps of Engineers, at 2 p. m., January 7, 1892, in response to advertisement dated Quincy, Ill., December 7, 1891.

No.	Name and residence of bidders.	Dynamo.	Engine.	Lights.	Price.
1	Thomson-Houston Electric Co., Chicago, Ill.	3,000 watts, 75 volts.	N. Y. safety, 5 H. P. vertical.	1–2,000 C.P. arc; 4x8–16 arc lamps; 8–16 arc lamps.	$725.00
2	Central Electrical Construction Co., St. Louis, Mo.	30x16 C. P., 110 volts.	Shipman, 4 H. P	20x16 C. P. lamps; 1–150 C. P. search.	789.89
3	Ft. Wayne Electric Co., Ft. Wayne, Ind.	50 lights incandescent.	Upright, 5 H. P.....	20x16 C. P. lamps; 1–200 C. P. search.	960.00

All the above propositions rejected, not being favorable to the interests of the United States.

Abstract of proposals for rock and brush, season of 1892, improving Mississippi River between Des Moines Rapids and mouth of Illinois River, opened at 2 p. m., January 5, 1892, by Maj. E. H. Ruffner, Corps of Engineers, at Quincy, Ill.

No.	Names and residence of bidders.	Quantities bid.	Material.	Place of delivery.	Price.	Remarks.
		Cubic yards.			*Cents.*	
1	Henry L. Hart, Louisiana, Mo.	10,000	Rock ...	Louisiana, Mo	*62	
	......do................	10,000	Rock ...	Hamburg, Ill	*66	
	......do................	15,000	Brush ..	At either of above.	*29½	
2	Reid, Brosi & Ebert, Quincy, Ill.	5,000 to 15,000	Rock ...	Lagrange, Mo.....	*69⅞	
3	John Guilfoyle and Henry Wellenbrusche, Lagrange, Mo.	5,000	Rock ...	....do	72	Only one copy—that incomplete.
4	Zach. Fielder, Hannibal, Mo.	....	Rock ...	....do	85	Only two copies and they signed only on specifications.
	......do................	....	Rock ...	Quincy, Ill.........	85	
	......do................	....	Rock ...	Hannibal, Mo.....	72	
	......do................	....	Rock ...	Louisiana, Mo.....	72	
	......do................	....	Rock ...	Clarksville, Mo...	72	
	......do................	....	Rock ...	Hamburg Bay	70	
5	Hannibal Lime Co., Hannibal, Mo.	6,000	Rock ...	Hannibal, Mo.....	*53	On 4-foot stage and above.
	......do................	4,000	Rock ...	....do	*54½	
6	Whitney Gilbreath, Ava, Ill.	20,000	Brush ..	Nearest attainable point to work.	38	On 5-foot stage and above.
7	Frederick W. Menke, Quincy, Ill.	2,500	Rock ...	Quincy, Ill.........	*62	
8	Charles C. Pratt and George N. Cash, Louisana, Mo.	Any part of 15,000.	Rock ...	Louisiana, Mo	67	

*Accepted and written contract made.

Y 3.

IMPROVEMENT OF DES MOINES RAPIDS, MISSISSIPPI RIVER.

There was available for this work July 1, 1891, the sum of $10,230.99.

During the year operations consisted in completing the raising of the lock walls, in filling and grading the lock grounds, and the laying of slope wall around the slopes at the upper end of the Middle Lock, in accordance with approved project, and in protecting portions of the canal embankment.

The work remaining to be done under approved project is the removal of a small amount of rock above grade, the completion of the sluice at Prices Creek, and the completion of the protection of the canal embankment. It is probable that after this work is carried out a balance will still be available, which balance can be applied to advantage in the construction of a permanent machine shop at the Lower Lock, a timber shed at the dry dock, guide piers above the closed part of the canal, or in widening portions of the channel, as may seem best. All of these works are desirable.

No further appropriation is required for the completion of this improvement in accordance with approved project.

Details of work are given in the appended report of Mr. M. Meigs, United States civil engineer, in local charge of work.

Abstract of appropriations.

By act approved—		By act approved—	
June 23, 1866	$200,000	August 14, 1876	$230,000
March 2, 1867	500,000	June 18, 1878 (allotment)	62,500
July 25, 1868 (allotment)	300,000	March 3, 1879	25,000
April 10, 1869 (allotment)	178,200	June 14, 1880	20,000
December 23, 1869	200,000	March 3, 1881	25,000
July 11, 1870	400,000	By act passed August 2, 1882	30,000
January 18, 1871	341,000	By act approved July 5, 1884	50,000
March 3, 1871	250,000	By act approved August 5, 1886	26,250
June 10, 1872	400,000	By act of August 11, 1888	35,000
March 3, 1873	400,000	By act of September 19, 1890	22,000
June 23, 1874	400,000		
March 3, 1875	480,000		4,574,950

Money statement.

July 1, 1891, balance unexpended	$10,230.99
June 30, 1892, amount expended during fiscal year	4,388.56
July 1, 1892, balance unexpended	5,842.43

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1892.

MAJOR: I have the honor to submit the following report of operations carried on under appropriation for "improving Des Moines Rapids, Mississippi River," during the fiscal year ending June 30, 1892:

Raising lock walls at Middle Lock.—In July, 1891, the work of raising the lock walls at the Middle Lock, of the filling and grading of the lock grounds at the Middle Lock, and the laying of slope wall around the slopes at the upper end of the Middle Lock, was completed according to the existing project.

Laying riprap face stone on canal embankment.—Owing to the extreme low water

which prevailed in 1891 aftér July 1, no stone could be towed, during the first half of the fiscal year from the quarries of the contractors, Patterson Brothers. A bank estimate was made July 31, 1891, and the getting out of stone was discontinued, as there seemed to be enough stone on hand to finish the work.

In April, 1892, the towing of stone for this work and the laying of the same in canal embankment at sections 58 to 61, inclusive, were resumed. This work was continued during May and June, and 996.68 cubic yards of rubblestone, to finish up slack places in the embankment and complete the work, were purchased from Patterson Brothers, at 55 cents per cubic yard.

The completion of protection of the canal embankment virtually finishes the canal, which has been under more or less continuous construction since October, 1867.

Patterson Brothers have furnished during the past fiscal year the following quantities of stone, which stone has been placed in bank:

Riprap face stone	cubic yards..	1,017.00
Rubble stone	do....	996.68

Statement of amount of slope wall laid from July 1, 1891, to June 30, 1892.

April, 1892	square yards..	126.00
May, 1892	do....	984.85
June, 1892	do....	161.00
Total	do....	1,271.85

I have been assisted by Mr. S. Edwards, superintendent, Mr. John R. Carpenter, overseer, and Mr. O. S. Willey, clerk and draftsman, in carrying on the above work.

No contracts were entered into during the past fiscal year.

The balance available at the close of fiscal year may be used for building a suitable machine shop and timber shed, for constructing guide piers in the channel above the closed part of the canal, or for widening difficult parts of the channel, as may be deemed best. All of these works are most desirable and urgently needed.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 4.

OPERATING AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open for navigation during the year 234 days, during which time there passed through it 577 steamboats and 191 barges, carrying 10,260 passengers, 12,228 tons of merchandise, and 63,210 bushels of grain. There also passed through the canal 140,654,084 feet of lumber, 24,514,000 feet of logs, 61,141,137 shingles, and 39,476,926 laths.

The expenses of operating and caring for the Des Moines Rapids Canal and Dry Dock, including extensive dredging and the ordinary repairs to gates, machinery, and plant during the past year have been $51,550.17. These expenses are provided for by an indefinite appropriation made by act of Congress of March 3, 1881.

The gates at the lower lock will have to be rebuilt during the coming year, and ordinary repairs to the other gates, the culverts, and canal embankment will be needed.

The canal has been thoroughly covered by the dredges during the past year, and large deposits, which have been accumulating for years, have been removed.

During the past year the dry dock has been constantly in use. At

times when the use of the dock was not required for repairs to portions of the Government plant, or not fully occupied for such purpose, boats and barges belonging to private parties have been docked and repaired at the dry dock, $129 dockage fees having been collected during the fiscal year for such use of the dock by private parties. It is desirable, when circumstances permit, that a shop with woodworking machinery and a storage shed for lumber be provided at the lower end of the dock. The expense of operating the canal will be slightly increased by the operating of the dry dock as an accessory work, but it is hoped that such increase will be more than offset by the increased facilities furnished for repair of Government boats and the amounts received from private parties for use of the dock.

The boom, constructed in accordance with act of Congress, for connecting outer wall of the canal with the pier of the Keokuk and Hamilton Bridge, requires repairs and must be taken into the canal at the close of navigation and put out again in the spring. An item for the expense of such repair and labor is included in estimate of cost of operating and caring for canal for the coming fiscal year.

Tables are given herewith showing details of expenditure and traffic, and comparative expenditure and traffic statements are submitted. A list of vessels docked at the dry dock at the Des Moines Rapids Canal during the past fiscal year is appended.

The operating and care of the canal and dry dock are in the immediate charge of Mr. M. Meigs, United States civil engineer, whose report is appended.

Abstract of appropriations.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, for fiscal year ending—	
June 30, 1882	45,000.00
June 30, 1883	75,000.00
June 30, 1884	47,000.00
June 30, 1885	40,500.00
June 30, 1886	43,000.00
By act approved March 3, 1881, for fiscal year ending—continued.	
June 30, 1887	$44,000.00
June 30, 1888	42,000.00
June 30, 1889	39,000.00
June 30, 1890	43,837.97
June 30, 1891	43,995.80
June 30, 1892	44,000.00
Total	617,333.77

Money statement.

July 1, 1891, balance on hand	$1.80
June 30, 1892, amount drawn from Treasury under indefinite appropriation	44,000.00
	44,001.80
June 30, 1892, amount expended during fiscal year	43,968.92
June 30, 1892, balance on hand	32.88
July 1, 1892, outstanding liabilities (for operations of June, 1892, the requisition for funds for payment of same not having been filled before the close of the fiscal year ending June 30, 1892)	7,581.25

List of vessels docked at the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1892.

Designation.	Date of entering dock.	Date of leaving dock.
Steamers:		
Scotia*	July 31, 1891	Aug. 1, 1891
Pittsburgh*	Aug. 10, 1891	Aug. 11, 1891
Success	Aug. 19, 1891	Aug. 27, 1891
Ravenna*	Aug. 29, 1891	Aug. 30, 1891
Vixen	Sept. 7, 1891	Sept. 23, 1891
Lumberman*	Sept. 29, 1891	Sept. 30, 1891
City of Quincy*	Oct. 25, 1891	Oct. 25, 1891
Eagle*	Apr. 6, 1892	Apr. 7, 1892
Fury	Apr. 12, 1892	Apr. 14, 1892
General Barnard	Apr. 20, 1892	May 3, 1892
Kit Carson*	May 17, 1892	May 17, 1892
Steam launch:		
Lucia	Nov. 18, 1891	Mar. 14, 1892
Dredges:		
Ajax	Mar. 31, 1892	Apr. 4, 1892
Vulcan	Apr. 12, 1892	Apr. 14, 1892
Do	June 11, 1892	June 12, 1892
Dump boats:		
No. 5	May 20, 1891	Sept. 2, 1891
"C"	July 10, 1891	July 14, 1891
"B"	July 28, 1891	Aug. 19, 1891
Do	Sept. 2, 1891	Oct. 9, 1891
No. 1	Oct. 25, 1891	Oct. 25, 1891
No. 2	....do	Mar. 14, 1892
Dump boats—cont'd.		
No. 4	Nov. 18, 1891	Mar. 31, 1892
No. 10	Apr. 14, 1892	Apr. 20, 1892
No. 8	....do	Apr. 29, 1892
"D"	Apr. 29, 1892	May 3, 1892
No. 6	....do	May 17, 1892
"A"	May 9, 1892	May 24, 1892
"C"	June 14, 1892	June 17, 1892
Quarter boats:		
No. 118	June 20, 1891	July 10, 1891
No. 59	Apr. 12, 1892	Apr. 14, 1882
Barges:		
No. 40	July 10, 1891	July 18, 1891
No. 48	July 28, 1891	July 31, 1891
Barge of steamer Annie Barnes*	Sept. 29, 1891	Sept. 30, 1891
"F"	Oct. 2, 1891	Oct. 3, 1891
No. 31†	....do	....
No. 8 of steamer Musser*	Oct. 31, 1891	Nov. 1, 1891
No. 82	Apr. 4, 1892	Apr. 9, 1892
"K"	Apr. 9, 1892	....do
"E"	Apr. 14, 1892	Apr. 20, 1892
"H"	....do	June 2, 1892
No. 88	May 3, 1892	May 17, 1892

* Belongs to private parties. † Condemned and destroyed.

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1892.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1891.								
July	$375.00			$375.00	$1,420.00	$71.87	$6.90	$1,498.77
August	375.00	$6.10		381.10	1,635.00	220.99	621.79	2,477.78
September	375.00	3.05		378.05		69.80	781.86	851.66
October					1,565.00	210.00		1,775.00
November	375.00	70.15	$42.88	488.03	1,555.82	58.89	516.06	2,130.77
December	375.00	13.25	25.99	414.24	2,939.84	93.52	652.75	3,686.11
1892.								
January	762.50	14.43		776.93	1,426.33	30.00	385.94	1,842.27
February		3.95		3.95		67.73	23.73	91.46
March	445.00	16.31	45.44	506.75	1,417.00		541.23	1,958.23
April	750.00		21.44	771.44	2,953.50		398.06	3,351.56
May	125.00	24.05	75.00	224.05	1,550.00	237.07	621.35	2,408.42
June	537.50	4.75		542.25	1,637.49	553.11	462.53	2,653.13
Total	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1891.					
July					$1,873.77
August			$102.12	$102.12	2,961.00
September			238.59	238.59	1,468.30
October		$18.68	6.47	25.15	1,800.15
November	$145.35	21.00	148.94	315.29	2,934.09
December		.50	112.11	112.61	4,212.96
1892.					
January			729.88	729.88	3,349.08
February			4.61	4.61	100.02
March		7.30	384.67	391.97	2,856.95
April	1,883.55		417.57	2,301.12	6,424.12
May	1,490.75	2,685.85	1,050.24	5,226.84	7,859.31
June	7,813.58	3,637.19	1,064.27	12,515.04	* 15,710.42
Total	11,333.23	6,370.52	4,259.47	21,963.22	* 51,550.17

* Includes $7,581.25 liabilities outstanding July 1, 1892.

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1892.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.
1891.					*Tons.*	*Bushels.*
July	64	60	61	5,494	4,059	39,890
August	54	56	42	2,858	1,981	1,890
September	30	32	12	147	347	200
October	34	32	23	5	437	....
November	33	30	9	6	200	....
1892.						
March	13	11	10	10	34	2,462
April	81	14	17	104	8,482	2,893
May	39	5	5	39	882	13,025
June	37	2	12	1,597	806	2,850
Total	335	242	191	10,260	12,228	63,210

Month.	Lumber.	Logs.	Shingles.	Lath.	Lockage at one lock.
1891.	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	36,884,785	9,413,000	16,461,900	9,163,665	314
August	31,906,566	4,045,000	17,340,250	9,688,540	244
September	23,835,887	4,708,000	10,270,000	5,862,046	180
October	25,800,718	4,398,000	11,190,917	7,848,675	202
November	17,383,129	900,000	5,478,070	5,453,000	77
1892.					
March	1,800,000	1,050,000	150,000	800,000	37
April	3,042,999	....	250,000	661,000	146
May	....	....	....	....	33
June	....	....	....	....	....
Total	140,654,084	24,514,000	61,141,137	39,476,926	1,233

Comparative expenditures of operating and care of Des Moines Rapids Canal for the fiscal years 1882–'92.

Year.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1882	$3,710.00	$161.69	$550.62	$4,422.31	$21,122.70	$1,654.06	$1,946.03	$24,722.79
1883	4,821.12	289.86	449.52	5,560.50	25,813.40	2,216.87	3,203.01	31,233.28
1884	5,045.22	209.12	665.62	5,519.96	17,654.23	4,344.51	1,291.20	23,289.94
1885	5,015.00	245.31	573.88	5,834.19	17,615.97	1,995.92	5,237.88	24,849.77
1886	5,225.00	209.12	432.10	5,866.22	17,731.76	2,226.23	5,652.87	25,610.86
1887	4,375.00	85.19	424.48	4,884.67	18,326.23	2,752.80	3,775.59	24,854.62
1888	4,870.00	154.04	481.70	5,505.74	16,892.82	1,942.94	7,972.29	26,808.05
1889	3,750.00	26.80	318.82	4,095.62	17,241.79	2,277.97	3,689.20	23,208.96
1890	4,425.00	120.84	238.03	4,783.87	18,245.07	2,376.55	7,848.88	28,470.50
1891	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31
1892	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16

Year.	Dredging canal.					Miscellaneous.	Grand total.
	Labor.	Supplies.	Repairs.	Contract.	Total.		
1882	$2,340.43	$572.09	$846.58	$14,080.39	$17,839.49	$68.75	$47,053.84
1883	4,765.93	1,538.80	598.04	30,666.17	37,568.94	3,564.07	77,926.79
1884	7,485.45	4,789.32	1,262.02	....	13,536.79	536.73	43,283.42
1885	3,353.12	8,580.69	1,888.73	....	13,822.54	....	44,506.50
1886	4,984.55	3,017.49	3,530.41	....	11,532.45	....	43,009.53
1887	6,149.45	3,810.12	2,453.98	....	12,413.55	....	42,152.84
1888	5,084.77	2,267.62	1,808.85	....	9,161.24	1,327.32	42,802.35
1889	5,573.56	3,528.06	2,479.17	....	11,580.79	....	38,885.37
1890	3,196.58	1,260.78	6,284.07	....	10,741.43	....	43,995.80
1891	3,563.51	1,906.63	702.61	....	6,172.75	....	44,998.20
1892	11,333.28	6,370.52	4,259.47	....	21,963.22	....	51,550.17

Comparative traffic statement showing the total traffic that has passed through the canal since its opening in 1877 by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockages at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1878....	670	548	....	53, 346	737, 415	25, 000, 000	....	4, 000, 000	3, 700, 000	824
1879....	802	454	5, 088	64, 658	2, 192, 642	33, 347, 612	8. 086, 000	8, 721, 796	11, 749, 000	1, 564
1880....	967	651	13, 231	78, 989	2, 197, 469	21, 832. 478	13, 160. 960	27, 863, 640	30, 561, 000	2, 497
1881....	840	276	10, 003	44, 962	1, 154, 092	52, 256, 235	11, 013, 410	11, 657. 655	15, 091, 000	1, 339
1882....	760	444	8, 588	29, 043	781, 817	17, 150, 011	4, 475. 000	3, 112, 825	4, 885, 250	2, 292
1883....	1, 107	705	9, 192	43, 359	729, 174	13, 093, 325	1, 040, 000	11, 558, 000	4, 435, 000	1, 353
1884....	913	245	13, 057	54, 215	470, 580	57, 018, 151	9, 399, 764	15, 924, 645	25, 182, 250	1, 908
1885....	889	169	13, 065	54, 120	776, 432	43, 110, 797	2, 779, 670	13, 473, 205	25, 018, 750	1, 270
1886....	784	218	22, 221	56, 001	465, 681	22, 769, 823	3, 195, 360	4, 302, 800	8, 253, 000	755
1887....	990	318	20, 797	52, 815	366, 432	178, 754, 876	24, 827, 000	19, 961, 781	90, 450, 922	1, 717
1888....	595	235	8, 330	33, 160	143, 037	166, 827, 752	34, 505, 000	83, 642, 450	49, 848, 840	1, 749
1889....	1, 022	288	22, 880	50, 008	381, 559	118, 508, 045	26, 333, 320	50, 221, 099	37, 413, 810	1, 941
1890....	924	477	14, 529	71, 453	397, 788	146, 078, 329	26, 689, 300	44, 316, 167	73, 540, 370	1, 827
1891....	878	357	15, 801	45, 217	364, 878	193, 358, 089	37, 176, 150	59, 350, 595	87, 259, 690	1, 895
1892....	577	191	10, 260	12, 228	63, 210	140, 654, 084	24, 514, 000	39, 476, 926	61, 141, 137	1, 233

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1892.

MAJOR: I have the honor to submit the following report on "operating and care of Des Moines Rapids Canal" for the fiscal year ending June 30, 1892:

The canal was open to navigation 234 days and closed 132 days. Navigation closed November 20, 1891, and opened April 1, 1892, though a few boats passed through the canal after and before these dates during the period that the canal was formally closed to navigation.

Extremes of low and high water have occurred during the fiscal year. From July 1, 1891, to the close of navigation, one long-continued low-water period prevailed, the river reaching, on October 1, 1891, the unprecedented low stage of 0.25 foot below the low water of 1864, the lowest previously recorded stage during the season of navigation and when not influenced by ice gorges. In 1892 the canal opened with a stage at the lower lock of 4.9 feet above low water of 1864, and the river continued to rise, the stage on June 30, 1892 being 19.3 feet above low water of 1864, this stage being only 1.7 feet and 0.3 foot less than the highest stages in 1851 and 1888, respectively.

The high water has, of course, greatly affected the amount of traffic passing through the canal, nearly all the boats and rafts being able to pass over the rapids outside of the canal since the middle of April, 1892.

Repairs to canal embankment.—Very little repairs to canal embankment were required. At section 33 a leak has developed, and at the dry dock the old leaks from the canal into the dock have increased, but no repairs have been made as yet, and the leaks showed no signs of danger to the canal even at extreme high water.

Repairs to gates, machinery, buildings, etc., at locks.—Provision was made in the project for the present fiscal year for rebuilding of gates at Lower Lock. Four thousand dollars was allotted for this purpose, but as the gates, upon careful examination. seemed able to go without repairs for another year, the allotment was not expended. At the Middle Lock some repairs were made to the lower culvert gate opening on the river side and a broken gate was replaced.

The machinery of the three locks was overhauled and new packing put in the pumps and hydraulic cylinders.

A painter was employed in painting the buildings and fences at the three locks and the engine house at the Lower Lock. These buildings and fences were last painted in 1877.

Repairs to plant.—The steam launch *Lucia* was docked and thoroughly repaired, many rotten plank being cut out and replaced, the engines being lined up, and the furnace being rebuilt. The canal dredge *Ajax* was docked, partly calked, and bolts tightened up before beginning work in the canal. The dredge lay all winter at Rock Island, Ill., having been caught there by the ice in the middle of November, and some needed repairs to dredge were therefore omitted. The dump boats and barges of the canal plant received attention from time to time as it became necessary. A coal barge, "K," for use at the canal was built at spare times and almost entirely of

stock on hand taken from barges previously condemned and broken up. The dimensions of this coal barge are 50 feet by 14 feet by 3 feet.

Boom below Lower Lock.—The boom connecting outer wall of the canal with the pivot pier of the Keokuk Bridge has been invaluable to the river interests during the high water of May and June, 1892. It has stood all tests satisfactorily, and will serve as a model for those at the various bridges along the river, being, with the exception of the one at Clinton, the only satisfactory boom in use along this part of the Mississippi River. The only trouble it has occasioned was the collection of drift during the extreme high water, when it required the services of one of the towboats at work in the canal to dislodge accumulations of floating drift that at times became quite serious. Fallen trees, 2 feet in diameter, at times lodged in the chains of the boom, and collected great rack heaps above them that made considerable hard work necessary for their removal.

The boom was removed from its customary position at the close of navigation and stored in the canal at a much lower stage than was heretofore thought practicable, owing to the boom grounding, as it was supposed, on the rocks above the bridge. The low stage at which it was removed (0.65 foot above low water of 1864), and the manner in which it stood high water, have served to relieve all doubts as to the adaptability of the boom to its location.

The boom was docked in the dry dock during the early spring, and a large amount of sediment that had accumulated inside of its hollow spaces was removed by means of scrapers and by washing. The removal of this sediment will have to be attended to periodically. The draft of the boom was decreased some 6 inches by thus lightening it. The fence on the boom should be painted to preserve it from the weather. This will cost about $500.

Machine shop at Lower Lock.—The machine shop was worked throughout the year in making general repairs to the Government plants of the canal and other works of improvement. A small dynamo machine and engine was built for the canal launch, and they work very satisfactorily. The work of the machine shop now aggregates nearly $45,000.

A plan for a new shop to replace the old and temporary building of wood, which has more than twenty times been saved from burning up almost by a miracle, has been prepared. The new shop will be a two-story, iron-roof, brick structure, the upper floor being for the storing of the many valuable patterns of lock and steamboat machinery belonging to the canal and other appropriations.

Survey of the canal.—A survey of the canal was made in September, 1891. It showed an increase in the deposits in the canal and the necessity for radical dredging.

Dredging canal.—Early in April, 1892, canal dredge *Ajax*, with towboat *Vixen* as tender, dredge *Phœnix*, with towboat *Fury* as tender, and dredge *Vulcan*, with towboat *Success* as tender, were put at work in removing deposits from the canal bottom. About April 20, double crews were put on dredges *Ajax* and *Phœnix* and their towboats, and, from that time to June 30, 1892, these dredges and boats were run night and day. The fact, developed on previous occasions, that the night work rarely failed to exceed that done during the day, was again verified, thus more than doubling the output of the dredges with much less than double the expenditure.

The tow averaged 5 miles, the high water prevailing during most of the time allowing the dumping of material just outside of the Guard Lock and below the Keokuk and Hamilton Bridge. At the latter point, about 10,000 cubic yards were dumped at the request of the city authorities of Keokuk, for filling the levee, which was very low at that point. Outside of the Guard Lock, the mud deposited forms a valuable reinforcement to the embankment at places which showed weakness during the high water of 1888.

Materials dredged and removed:

April, 1892	cubic yards..	26,380.77
May, 1892	do....	56,439.48
June, 1892	do....	66,798.00
Total		149,618.25

Taking into consideration additional expenses of more than $2,000 for needed repairs to boats and machinery, and for a heavy outlay for rope and other various supplies, the dredging has been done at an average cost per cubic yard, exclusive of general superintendence and office expenses and charges for use and deterioration of plant, of 14.68 cents. Previous contracts have been awarded at prices per cubic yard of 29¾ cents and 33¼ cents, so that the comparison with the present year's cost is most favorable to the Government plant.

Operating dry dock at Des Moines Rapids Canal.—The dry dock has been in constant use during the past year. Nine private boats were docked and repaired, and lesser repairs, such as required only a few hours' work, were made.

The dry dock will be of constantly increasing use to boats of private individuals for repairs of an accidental character; that is, such as are caused by grounding on the rapids or breakages requiring dockages for a few hours only.

The present regulations require private boats to bring all tools and material for repairs with them, and this provision greatly militates against the more extended use of the dock by such boats as would naturally seek it when in extremity. It would be very much better and would make the dock of much more use to the general public could the authorities in charge of the dock be empowered to furnish boats desiring to make use of its facilities such material on hand as would be required for minor repairs, the cost of same to be charged to the boat and the articles used to be replaced with the funds thus received.

A storage shed for lumber and for the shelter of workmen during inclement weather is greatly needed. I repeat my estimate of $2,500 for a suitable structure, not less than 70 feet long by 26 feet wide.

The dry dock and the boom at the Lower Lock being added to the equipments of the canal have added a considerable amount to the sum required for the annual maintenance of the canal. The boom requires the employment of one extra man at the Lower Lock and the dry dock requires the employment of a dock master and master carpenter, who should not receive less than $100 per month. In my last annual report I made an estimate of the additional sum required for dry dock and boom at Lower Lock, and it is here repeated:

1 dock-master and carpenter, twelve months, at $100 per month	$1,200
1 watchman, twelve months, at $45 per month	540
Supplies	200
Miscellaneous repairs to buildings and grounds	300
Total	2,240

Business of the canal.—Low water during the first half of the fiscal year caused all traffic to pass through the canal. During most of the latter half of the fiscal year the water was so high that hardly any boats came through the canal.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

Y 5.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MINNEAPOLIS AND DES MOINES RAPIDS.

Under this head of appropriation are carried on works for the permanent improvement of through navigation. These works, which have been fully described in previous reports, consist in constructions of rock, brush, piles, and gravel, which close side chutes and reduce the low-water channel to a proper width, and in the protection of caving banks. Between Minneapolis and St. Paul, in addition to works of construction, bowlders are removed and channels are dredged through gravel bars; at Rock Island Rapids, guide piers, to aid in the navigation of the rapids at night during favorable stages and in calm weather, and wing and closing dams, to increase the depth of water at some of the chains, are built, and rock ledges within the proposed channel limits are removed by drilling, blasting, and dredging. The appropriation also provides for a certain amount of dredging and other temporary work for the more rapid and immediate removal of obstructions to navigation.

At the commencement of the fiscal year there was available the sum of $360,308.35, and work was carried on vigorously during 1891; but, owing to the high stage of water prevailing, little work was done in 1892 to June 30, except a limited amount of dredging between Minne-

apolis and St. Paul. A commencement was made on the contract work between Bellevue and Savanna in May, 1892, but operations were soon suspended on account of high water.

Under approved projects work of dam construction, shore protection, and removal of rocks and bowlders has been carried on during the past year by day's labor and Government plant between Minneapolis and St. Paul, between St. Paul and Prescott, between Prescott and Lake Pepin, between Minneiska and Lacrosse, in vicinity of Lacrosse, Crooked Slough, and Clinton, at Rock Island Rapids, at Montrose Harbor, and between Keithsburg and Montrose. By informal agreement work with private plant has been carried out between Minneapolis and St. Paul, between St. Paul and Prescott, in Cassville Slough, and at Port Byron Harbor. Under formal contract work was done between Reads and Minneiska, at Prairie du Chien, and between Bellevue and Savanna.

Surveys and examinations were made between Minneapolis and St. Paul, between Prescott and Redwing, below Dubuque, and between Bellevue and Savanna.

The buoys and ranges on the Rock Island Rapids were maintained.

Extensive repairs have been made to the plant belonging to this appropriation, and 20 new barges and 1 quarter boat were added during the season.

The details of all the above-mentioned work are fully given in the appended report of Assistant Engineer C. W. Durham, which includes full extracts from the reports of Superintendents J. D. Du Shane, W. A. Thompson, and J. C. McElherne, and the report of M. Meigs, United States civil engineer, covering that of Superintendent S. Edwards.

The river and harbor act of September 19, 1890, under appropriation for "improving the Mississippi from the landing on the west bank below the Washington Avenue Bridge, Minneapolis, to the Des Moines Rapids: Continuing improvement, $500,000," provided for specified work at special localities by definite allotments from this general appropriation for the improvement of through navigation. These special allotments are for work at the following localities: (1) Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge (St. Paul to Minneapolis), $50,000; (2) East Channel, Prairie du Chien, $30,000; (3) Port Byron, Ill., $5,000; (4) Burlington, Iowa, $5,000; (5) Montrose, Iowa, $2,000. The part of the act reserving the above-named allotments is given in the following extract from the paragraph of the act which refers to this general appropriation:

> Of which sum thirty thousand dollars, or so much thereof as may be necessary, shall be expended by the engineers in charge in removing the sand bars and other obstructions to navigation in the East Channel of the Mississippi River opposite the prairie, on which the city of Prairie du Chien, in the State of Wisconsin, is located, the same being between Minneapolis and Des Moines Rapids; of which sum also fifty thousand dollars shall be expended between the Chicago, Saint Paul, Minneapolis and Omaha Railroad Bridge at Saint Paul, and the Washington Avenue Bridge, Minneapolis, in dredging, removal of gravel, bowlders, and broken rock, and the construction of dams and revetments; and in the discretion of the Secretary of War, the sum of five thousand dollars, or so much thereof as may be necessary, shall be expended in removing the bar in the river at Port Byron, in the State of Illinois; five thousand dollars at Burlington, Iowa; and two thousand dollars at Montrose, Iowa.

The act of Congress of August 11, 1888, provided in a general way for work of improvement between Minneapolis and St. Paul; but the act of September 19, 1890, allotted a specific amount ($50,000) for carrying on specified work on this section of the river. In accordance with

the provisions of the river and harbor act of September 19, 1890, a preliminary project for the commencement of the work of removing bowlders was presented September 30, 1890, and approved October 14, 1890, this project being intended to cover the small amount of work that could be done during remainder of the season of 1890, and a complete project was presented February 23, 1891, and approved February 28, 1891. The latter project proposed a continuation of the work of removing bowlders, the construction of dams and revetments, and the dredging of gravel bars; and considerable work under this project, in the removal of bowlders, the construction of bank revetment, and the dredging of gravel bars, was carried on during season of 1891. In 1892, owing to the very high stage of water prevailing during the spring and early summer, no work, beyond resuming the work of dredging gravel bars, repairing the plant pertaining to the work, and preparing to resume operations when the stage of water permits, has been done. As stated in former reports and projects, I am of the opinion that, while the lower portion of the stretch of river here considered may be made as favorable for navigation as the river below St. Paul by the work proposed, the upper portion or rapids can only be radically improved by the construction of locks and dams.

In accordance with provisions of river and harbor act of September 19, 1890, a project for carrying on work in vicinity of Prairie du Chien was presented December 31, 1890, and approved January 8, 1891. This project contemplated the construction of certain dams under formal contract, after due advertising, and, in accordance with project, this work was performed in 1891, under contract with Patterson Brothers, of Keokuk, Iowa.

The river and harbor act of September 19, 1890, provided for dredging in the harbors of Port Byron, Burlington, and Montrose. A project for this dredging work was presented September 30, 1890, and approved October 14, 1890. Under this project a portion of the work desired at Burlington was carried out during the fall of 1890 by the use of Government dredge. An additional project for dredging at Port Byron and Montrose harbors was presented February 23, 1891, and approved February 27, 1891, and a modification of the part of additional project that referred to work at Port Byron was submitted June 15 and approved June 20, 1891. Under the additional project and its modification dredging in the harbors of Montrose and Port Byron was completed in 1891, the work at the former place being performed by use of a Government dredge and hired labor and at the latter place under informal agreement with A. J. Whitney, of Rock Island, Ill. These works have been carried out, not because the harbors were in any worse condition than at other and possibly more important points, but for the reason that special allotments were provided for the work.

According to the terms of the river and harbor act of September 19, 1890, any balances of the allotments of $30,000 for East Channel, Prairie du Chien, $5,000 for Port Byron Harbor, $5,000 for Burlington Harbor, and $2,000 for Montrose Harbor that remained unexpended after the completion of the work contemplated by the act to be performed under said allotments may be applied to the general improvement of through navigation. Under these allotments there have been expended on the work specified in the act: East Channel, Prairie du Chien, $28,430.47; Port Byron Harbor, $5,000; Burlington Harbor, $1,905.62; and Montrose Harbor, $1,278.93. A request was made, under date of January 8, 1892, for authority to transfer to allotment for general improvement of through navigation from allotment for East

Channel, Prairie du Chien, $1,569.53, and from allotment for Montrose Harbor, $721.07, the amounts being the unexpended balances of these allotments after completion of work. The authority requested was granted January 11, 1892, and the transfer of balances was made January 13, 1892. It being thought probable that additional work at Burlington might become necessary, as only a portion of the desired work had been completed, the available balance, $3,094.38, of this allotment was not transferred to allotment for general improvement, but retained for such probable use.

During the past year the construction of new bridges across the Mississippi River at Winona, Lacrosse, Lyons, and Muscatine has been completed, with the exception of certain accessory works for the facilitation of navigation through or under them, and other new bridges at St. Paul, Winona, and Clinton are being built.

My reports for 1886 and 1888 contained tables giving the cost of materials furnished by contractors and bought in open market, from 1878 to 1887, inclusive. To carry the information up to the close of the working season of 1891, I give the following table:

Comparative cost of materials, 1888–1891.

Locality of delivery.	Rock (per cubic yard).			Brush (per cubic yard).		Poles, each.
	In place.	On United States barges.	On bank.	In place.	On United States barges.	
1888.						
West St. Paul		$0.45				
St. Paul to Lake Pepin					$0.26	
Nininger		.45				
Do		.47				
Stockholm		.58	0.42\frac{3}{10}$		.27	$0.03
Do		.68½				
Alma		.73$\frac{3}{10}$				
Fountain City		.64½			.25	.02½
Nauvoo		.62½				
Montrose					.27	.03
Do					.28	
1889.						
St. Paul		.50				
Minnesota River and Pigs Eye Island					.28	.03
Robinson Rocks		.54			.28	.03
Do		.50				
Island No. 7					.28	.03
Merrimac		.57				
Pine Bend to Nininger					.28	.03
Grey Cloud Island					.25	.03
Do					.24	
Do					.28	
Nininger		.44¾			.26	.03
Hastings					.26	.03
Do					.28	
Do		.46			.26	
Prescott		.46			.26	.03
Do					.26	.03
Do					.26	.03
Prescott to Lake Pepin					.26	.03
Island No. 20		.46				
Diamond Bluff					.26	.03
Do					.26	.03
Diamond Bluff to Redwing					.25¾	.03
Head of Lake Pepin		.40			.25	.03
Reads Landing to Fountain City	$1.30			$0.50		
Minneiska					.26	.05
Alma		.68$\frac{3}{10}$				
Winona		.65				
Vicinity of Winona		.63½			.24	.05
Homer		.65				
Trempealeau					.25	.05

Comparative cost of materials, 1888–1891—Continued.

Locality of delivery.	Rock (per cubic yard).			Brush (per cubic yard).		Poles, each.
	In place.	On United States barges.	On bank.	In place.	On United States barges.	
1889.						
Dakota					$0.24	
Dresbach		$0.63 3/16	$0.31 7/16			
Lansing			.45			
Heytman Landing		.65	.50			
Crooked Slough					.25	$0.02½
Lynxville		.65			.25	.02½
Cassville		.65	.45			
Buena Vista		.55				
Vicinity of Bellevue	$1.00					
Leclaire		.55				
Do		.40				
Sycamore Chain		.50				
Crab Island		.50				
Hampton		.50				
Campbell Island		.58				
Fairport to Muscatine	1.15			$0.40		
Vicinity of Keithsburg	1.20			.40		
Vicinity of Burlington		.63			.25	
Do		.65				
Sauerweins Bend					.25	
Dallas City		.65			.25	
Dallas		.65			.25	
Pontoosuc		.64	.55		.25	
Do		.65	.60			
Vicinity of Fort Madison	1.20			.40		
Fort Madison		.63			.25	.05
Nauvoo		.64			.25	
Montrose, vicinity of					.25	
Do					.23½	
1890.						
Grey Cloud Island					.26	
Nininger		.44½			.26	
Hastings					.26	
Prescott					.26	
Smiths Bar					.26	
Morgan Coulee					.26	
Lake City	1.09					
Reads Landing	1.15			.54		
Fountain City		.63½			.26	
Wilds Landing		.65				
Vicinity of Burlington		.65				
Dallas City		.65				
Pontoosuc		.55	.40			
Do		.65				
Nauvoo		.65				
1891.						
Mendota		.50				
Merrimac					.23	.02½
Gray Cloud Island					.18¾	.02½
Nininger		.42¼			.21⅞	.02½
Do					.18¾	
Hastings		.44			.25	.02½
Do					.21⅞	
Prescott to Lake Pepin					.19¾	.02½
Below Prescott					.21⅞	
Diamond Bluff					.18¾	.02½
Reeds Landing to Minneiska	1.20			.27		
Minneiska to Lacrosse					.20	.03
Do					.22	
Fountain City		.55				
Trempealeau		.54				
Richmond Chute		*.40				
Dakota		*.33				
Do		*.36½				
Do		*.40				
Dresbach		.50				
Lansing		.55				
Lynxville		.60			.20	.03
Prairie du Chien	.90			.40		

* Soft sand rock.

Comparative cost of materials, 1888–1891—Continued.

Locality of delivery.	Rock (per cubic yard).			Brush (per cubic yard).		Poles, each.
	In place.	On United States barges.	On bank.	In place.	On United States barges.	
1891.						
Cassville Slough	$1.20			$0.50		
Bellevue to Savanna	.90			.40		
Clinton		$0.60	$0.40		$0.25	$0.03
Leclaire		.65				
Keithsburg to Nauvoo					.25	
Burlington		.60	.50		.20	
Do		.64				
Dallas City		.55	.40		.25	
Do					.20	
Pontoosuc		.55	.40			
Do		.65				
Fort Madison		.60	.45			
Niota Chute			.40			
Nauvoo		.55	.40			
Do		.65				

Commercial statistics relating to the Upper Mississippi River are given in connection with the report on "operating snag boats and dredge boats on Upper Mississippi River." These statistics do not fully indicate the relations of this work to the interests of commerce and the general public. The influence which the Upper Mississippi River in an improved condition has upon freight rates must be taken as a measure of its importance. Of the amount of freight carried by railroads at river rates, as a result of the river competition, no figures can be given; but such amount is known to be very large during the season when navigation of the river is practicable.

During the past year the works heretofore constructed by the Government have continued to straighten and deepen the low-water channel of the river and to materially benefit the interests of commerce and navigation. That such benefit should continue and increase, it is necessary that the work of improvement be continued until the whole river is put under such control that the possibility of new obstructions appearing is done away with.

If the radical improvement of the Upper Mississippi River is to be continued and carried to the full limits which the immense interests involved justify, it is desirable that it should be carried on under liberal appropriations, so that the full benefit of the improvement may be secured at as early a day as is practicable. As an amount that can be profitably expended during the fiscal year ending June 30, 1894, I present an estimate of $866,666.67.

The improvement of the Upper Mississippi River is a work which can be best carried on so gradually as to give the river itself full opportunity to assist in the formation of proper channels, and, if carried to its fullest limits, the work must extend over many years. It does not now appear desirable, or even practicable, to prepare detailed plans for the whole river so long in advance of the time when it may be possible or necessary to carry out some of the work. The existing project for this work may therefore be said to be one of general methods and the execution of detailed plans for special localities. Under the conditions named no detailed estimates of cost of completing the entire work can well be now made. Projects for the expenditure of each appropriation, in accordance with approved plans and methods, are presented in

lieu of a general project for the completion of work. It has been the custom in carrying out work on the Upper Mississippi to select, when funds are available, such localities for improvement as may be at the time most detrimental to navigation. Each and every locality thus improved has a beneficial result on the navigation of the whole river, and, as the shoalest bars have been improved from year to year, the ruling navigable depth has been considerably increased. By this method the good effects of work are spread over the entire stretch of river, and the improvement of the river, considered as a whole, is made progressive, the expenditure of each successive appropriation resulting in further and immediate benefit to the interests of continuous navigation.

Summary of expenditures for calendar year ending December 31, 1891.

General improvement:		
St. Paul to Prescott	$22, 860. 93	
Prescott to Lake Pepin	8, 597. 32	
Reads to Minneiska	64, 337. 80	
Minneiska to Lacrosse	46, 687. 68	
Vicinity of Lacrosse and Crooked Slough	3, 525. 86	
Cassville Slough	5, 034. 33	
Bellevue to Savanna	22. 44	
Vicinity of Clinton	4, 357. 20	
Rock Island Rapids	36, 237. 32	
Keithsburg to Montrose	40, 643. 29	
Buoys on Rock Island Rapids	397. 93	
Purchase, construction, repair, and care of plant	31, 014. 39	
Surveys and gauges	1, 910. 36	
		$265, 626. 85
Special improvements:		
Minneapolis to St. Paul	*24, 689. 04	
East Channel, Prairie du Chien	†28, 430. 47	
Harbor at Port Byron	5, 000. 00	
Harbor at Montrose	1, 278. 93	
		59, 398. 44
Total		325, 025. 29

General statement of receipts and expenditures.

Expended by vouchers from the commencement of improvement to July 1, 1892:		
St. Paul to Des Moines Rapids		$1, 562, 496. 55
Minneapolis to Des Moines Rapids		965, 181. 42
Harbor at Lake City (St. Paul to Des Moines Rapids)		13, 372. 15
Practical test of Adams Flume (St. Paul to Des Moines Rapids)		‡22, 176. 83
Total		2, 563, 226. 95
Deduct amount received from sales of fuel	$946. 68	
Deduct amount received by transfer settlement with Quartermaster's Department, account of sale of fuel to officers	156. 29	
Deduct amount received from sale of rock	1, 078. 05	
		2, 181. 02
Net cost of improvement		2, 561, 045. 93

*Includes $1,334.02 liabilities outstanding December 31, 1891.
†Includes $450 liabilities outstanding December 31, 1891.
‡In addition to this amount Mr. Adams expended $8,000, appropriated by act of August 2, 1882, as a separate item.

Balances July 1, 1892:		
St. Paul to Des Moines Rapids	*$1,627.85	
Minneapolis to Des Moines Rapids	134,826.22	
		$136,454.07
Total appropriated		2,697,500.00

Abstract of appropriations.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000
March 3, 1879	100,000
June 14, 1880	150,000
March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved—	
July 5, 1884 (general improvement)	250,000
July 5, 1884 (applied to harbor at Lake City)	15,000
August 5, 1886	382,500
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000
By act of September 19, 1890	500,000
Total	2,697,500

Net expenditures on the various sections of the river between Minneapolis and the Des Moines Rapids from commencement of improvement to July 1, 1892.

Locality.	Distance.	Amounts.
	Miles.	
Minneapolis to St. Paul (Omaha Bridge)	11	$38,400.05
St. Paul (Omaha Bridge) to Prescott	32	533,580.57
Prescott to head of Lake Pepin	29	65,806.45
Harbor at Lake City		13,372.15
Foot of Lake Pepin to Alma	12	328,868.11
Alma to Winona Bridge	29	279,942.36
Winona Bridge to Lacrosse Bridge	31	154,520.61
Lacrosse Bridge to McGregor Bridge	72	120,884.52
McGregor Bridge to Dubuque Bridge	59	87,756.97
Dubuque Bridge to Clinton Bridge	67	58,217.29
Clinton Bridge to Rock Island Bridge	40	138,185.79
Rock Island Bridge to Keithsburg Bridge	58	70,071.85
Keithsburg Bridge to DesMoines Rapids	60	435,257.50
Surveys, gauges, and meter work		94,112.19
Snag and dredge boats and wrecking		39,431.66
Facilitating navigation through bridges		1,412.18
Plant at estimated value		79,048.85
Practical test of Adams Flume		22,176.83
Total		2,561,045.93

ST. PAUL TO DES MOINES RAPIDS.

Money statement.

July 1, 1891, balance unexpended:		
General improvement	$400.05	
Lake City Harbor	1,645.83	
		$2,045.88
June 30, 1892, amount expended during fiscal year:		
General improvement	400.05	
Lake City Harbor	17.98	
		418.03
July 1, 1892, balance unexpended, Lake City Harbor †		1,627.85
July 1, 1892, balance available, Lake City Harbor		1,627.85

*This balance pertains to Lake City Harbor.

†Two hundred and forty-eight dollars and forty cents liabilities on account of nonpayments "St. Paul to Des Moines Rapids" have been transferred to "Minneapolis to Des Moines Rapids."

MINNEAPOLIS TO DES MOINES RAPIDS.

Money statement.

July 1, 1891, balance unexpended:		
General improvement	$330, 820. 18	
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge	47, 687. 75	
Burlington, Iowa	3, 094. 38	
Montrose, Iowa	721. 07	
East Channel, Prairie du Chien	23, 382. 46	
Port Byron, Ill	3, 639. 14	
		$409, 344. 98
June 30, 1892, amount expended during fiscal year:		
General improvement	221, 352. 44	
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge	27, 714. 25	
Burlington, Iowa	0. 00	
Montrose, Iowa	0. 00	
East Channel, Prairie du Chien	21, 812. 93	
Port Byron, Ill	3, 639. 14	
		274, 518. 76
July 1, 1892, balance unexpended:		
General improvement	*111, 758. 34	
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge	19, 973. 50	
Burlington, Iowa	3, 094. 38	
		134, 826. 22
July 1, 1892, outstanding liabilities, general improvement	†302. 72	
July 1, 1892, amount covered by uncompleted contracts: General improvement	14, 956. 76	
		15, 259. 48
July 1, 1892, balance available: ‡		
General improvement	96, 498. 86	
Between Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge and Washington Avenue Bridge	19, 973. 50	
Burlington, Iowa	3, 094. 38	
		119, 566. 74
Amount that can be profitably expended in fiscal year ending June 30, 1894 §		866, 666. 67
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., March 14, 1892.

MAJOR: I have the honor to submit the following report of operations for the improvement of the Mississippi River in the division under my charge, extending from Minneapolis, Minn., to the vicinity of Keithsburg, Ill., for the calendar year ending December 31, 1891:

MINNEAPOLIS TO ST. PAUL.

This work was carried on during the season with a special allotment of $50,000 in act of September 19, 1890, and under project approved February 28, 1891.

The work projected consists in protecting caving banks, building dams of brush, rock, and gravel, dredging gravel bars, and removing rocks and bowlders from channel.

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* This allotment has been increased by the authorized transfer of $721.07 and $1,569.53, balances available January 13, 1892, of allotments for Montrose, Iowa, and East Channel, Prairie du Chien, respectively, the total amount transferred being $2,290.60.

† Of this amount $248.40 are nonpayments transferred from appropriation "St. Paul to Des Moines Rapids," $54.32 are retained percentage.

‡ An appropriation of $600,000 for improving Mississippi River between Minneapolis and mouth of Missouri River was made by the river and harbor act approved July 13, 1892.

§ For continuing work between Minneapolis and mouth of Missouri River.

Operations in this section, as were also operations between St. Paul and Prescott and between Prescott and Lake Pepin, were in local charge of Mr. J. D. DuShane, superintendent, whose report is given below nearly in full:

"The river and harbor act of September 19, 1890, provided that of the sum appropriated for improving the Mississippi River from Minneapolis to the Des Moines Rapids, 'fifty thousand dollars shall be expended between the Chicago, St. Paul, Minneapolis and Omaha Railroad Bridge at St. Paul and the Washington Avenue Bridge, Minneapolis, in dredging, removal of gravel, bowlders, and broken rock, and the construction of dams and revetments.' A preliminary project for beginning operations under this allotment was approved October 14, 1890. A project for continuing operations was presented February 23, 1891, and approved February 28, 1891. This project provides 'that the work shall be carried on by days' labor and use of Government plant, by purchase of materials in open market at prices fixed by competition, and by hire of dredges from private parties after due competition, provided Government dredges be not available.'

"To conform with the requirements of the act of Congress making the allotment for this work, it is proposed to remove bowlders and rocks from the river, and to do such dredging of gravel bars as will provide an open river channel. Where rock removal or dredging is necessary, it is proposed to secure a channel 200 feet wide and 3 feet deep at low water of 1864. This will provide, at ordinary low summer stages, a navigable depth of 4 feet or more. It is not expected, however, that this width and depth of channel can be fully accomplished with the present appropriation; consequently operations have been limited to the removal of bowlders and rocks projecting above grade, or above the natural bottom of the river, where the bottom was above grade, to dredging channels 100 feet wide through gravel bars, and to protecting only such banks as are at present most needing it.

"*Removing bowlders.*—Operations were resumed June 18, 1891. The United States launch *Emily* was used for towing. Several of the smaller barges on hand were transformed into derrick barges and provided with large and small grappling hooks for raising rocks from the river bed, the larger hooks being used in connection with the derricks and the smaller being hand hooks. Small boats were built for use in connection with the derrick barges to facilitate the handling of hooks and on which to place the rocks when first lifted from the river. At the beginning of operations but one derrick barge was used; two others were added during the season. The derricks, grappling-hooks, and small boats were built on the works as needed. Barge No. 34, fitted with a steam drill, was brought from the Des Moines Rapids Canal and used, after July 8, 1891, in connection with blasting bowlders and ledge rocks. Much hand drilling was also done in places which the drill boat could not reach. Dynamite, containing 40 per cent of nitroglycerin, was used as an explosive. The charges were fired by a blasting battery.

"The work of rock removal progressed upstream from the Short Line Bridge, at which point the river became seriously obstructive. The lower limit of the bowlders is, however, about one-half mile farther down river, namely, at the Marshall Avenue Bridge, and much work was performed between these bridges during the latter part of the season. Below the Marshall Avenue Bridge only a few isolated bowlders were found, which were broken up and removed while the fleet was passing up the river. All rocks removed from the channel were deposited out of the way, either on the shores or in the slough back of Meeker Island. From a point 1,370 feet below the Short Line Bridge to a point 380 feet above the Franklin Avenue Bridge, somewhat more than a mile, the river was thoroughly swept within the channel limits and all rocks were removed, excepting the small rocks forming the natural bottom of the river, which in some cases was above grade. For an additional distance of 210 feet above this upper point, and from the lower point to the Marshall Avenue Bridge, about 2,800 feet, all large rocks were removed. In the vicinity of the Franklin Avenue Bridge, about one-third of the total length of the rapids has been cleared, within the channel limits, of all rocks projecting above the natural river bottom. At some places above the Marshall Avenue Bridge dredging will be necessary to secure the adopted grade. One of the most troublesome places is near the foot of the rapids, about 700 feet below the Franklin Avenue Bridge, where the bottom, in the form of a bar or reef of small bowlders and gravel, is above grade for the entire channel width. Dredging will be needed also on and above the rapids.

"There were removed during the season 1,230.2 solid cubic yards of bowlders and ledge rocks. This amount does not include a very considerable quantity of small bowlders and pieces of rock, as only rocks 1 foot or more in diameter were measured and calculated.

"Operations of removing bowlders were suspended for the season November 6, and the fleet was taken to Boulanger Slough, where it was laid up for the winter November 12. While going down the river stops were made at Robinsons Rocks and at Nininger, where a number of rocks were removed from the channel.

"During the season of 1892, the work of rock removal should be continued above the

Marshall Avenue Bridge, on the rapids above the Franklin Avenue Bridge, and between the head of the rapids and the steamboat landing, below the Washington Avenue Bridge. Channels should be dredged through the gravel bars at the head and middle of Pike Island. In this connection, it may be stated that it is not thought an open-river channel over the rapids will be sufficient for the safe and easy passage of the larger classes of steamboats; but, until a system of improvement by lock and dam is completed, this stretch of river will be put to little commercial use, except for running logs to the boom works below Pike Island. Should locks and dams be built, much of the work at the head of and above the rapids, previously mentioned as work that should be done during 1892, would form part of the permanent improvement by this system.

"It will be necessary to provide a new hull for drill boat No. 34 before resuming operations. Also, several small barges, about 12 feet wide and 45 feet long, will be needed for use in connection with the derrick barges, as the barges (size 16 feet by 80 feet) used during the past season are too large for convenient handling in the swift water of the rapids.

"*Bank revetment.*—The towboat *Fury* and plant were transferred on August 22 from work between St. Paul and Prescott for the construction of bank revetment in the vicinity of Pike Island. On August 24 the protection of the left bank above the boom works was begun. This is a high, sandy bank, rapidly cutting away. This bank for a distance of 2,720 feet and a width of 36 feet, was protected with a covering of rock and brush of the usual construction. The right bank opposite the boom works was protected with a similar revetment 3,200 feet long and 40 feet wide. The bank of the island opposite the mouth of Minnehaha Creek was protected with a gravel revetment 800 feet long and about 25 feet wide. This revetment was made while the dredging of the gravel bar at Minnehaha was in progress, a part of the dredged material being used in the revetment. Of 1,946 cubic yards used, 250 cubic yards were cast on the bank by the dredge, 540 cubic yards were dumped against the bank from scows, and 1,156 cubic yards were unloaded by hand from barges. The cost of dredging this gravel was $441.25, or 22.67 cents per cubic yard; the labor of unloading by hand cost $148.16, or 12.82 cents per cubic yard. However, no charge for dredging was made against this work, as the dredging was for channel improvement, and the material used in the bank revetment would otherwise have been wasted.

"It was expected that these revetments could be built in four weeks, but, owing to the slow delivery of rock, the work was not completed until October 22. Under the circumstances, the plant could be fully used but a small part of each day, and, for this reason, the towboat *Fury* and fleet were withdrawn from this work on September 24 for operations below Prescott. The launch *Bessie* was used for towing after the *Fury* left. The tow being then downstream for loaded barges and the working force greatly reduced, made it possible for the launch to attend to this work.

Only a slight covering of rock, owing to the slow delivery, was put on the lower revetment opposite the boom works, and more should be added within a year or two.

There were used in the construction of bank revetments 5,376.7 cubic yards of rock, 4,917.7 cubic yards of brush, and 2,124 cubic yards of gravel.

The materials were purchased in open market, loaded on United States barges, at the following prices: Rock, 50 cents per cubic yard; brush, 18¾ cents, 21.78 cents and 23 cents per cubic yard; poles, 2¼ cents each.

Dredging.—As the Government dredges were fully occupied on other work, the dredging plant of Mr. C. H. Appleton, being the only outfit available, was hired, at the following rates per hour: $8 for dredging and towing 1 mile or less, $8.50 for dredging and towing from 1 to 2½ miles, $9 for dredging and towing from 2½ to 5 miles.

The first work undertaken was begun August 3, at Groveland Park, where the shoalest gravel bar existed. A channel 900 feet long, 100 feet wide, with a least depth of 4 feet at a stage of 1 foot at St. Paul, was dredged through this bar. The depth on this bar at the same stage before improvement was 18 inches. The first cut was cast into a bank on the lower side of the channel; the balance of the material excavated, which consisted of shell rock, coarse gravel and sand, was dumped back of islands in the vicinity.

Above Minnehaha a channel was dredged through the gravel bar. This cut is 985 feet long and 100 feet wide, with grade 3 feet below low water. The material was mostly wasted below islands in the vicinity.

At Minnehaha, where a fairly good channel existed, the dredging was confined to deepening it on the upper and lower sides of the bar and in widening the channel somewhat. Here a channel was made 100 feet wide, with grade 3 feet below low water. The gravel composing this bar is similar to that of the bars above, but smaller in size. Part of the material excavated was used in making the bank revetment at this place, and the balance was deposited in a deep pocket in the vicinity, with a view of correcting the channel.

The short bend above Fort Snelling was widened and straightened by dredging along the right bank and at the head of the low island opposite. About 50 feet in

width was dredged off the shoulder of this island. Five cuts were made along the right bank and eight cuts along the island. This bend was very much improved by the work done. To assist in correcting the channel at this place the material, which consisted of sand and mill refuse, was dumped in deep water below the point of the bluff a short distance above the head of the island.

At Pike Island dredging was begun through the gravel bar opposite the upper end of the revetment of the left bank; but, owing to the lack of space for dumping the dredged material operations were suspended before the completion of the channel at this point. Two cuts were made through the bar, forming a channel 450 feet long and 40 feet wide.

In addition to the dredging of channels through gravel bars, the dredge pulled one pile, which had been broken off in the channel under the Fort Snelling Bridge, and removed one sunken crib below Minnehaha, and the foundations of four cribs at Groveland Park.

Dredging operations between Minneapolis and St. Paul were suspended November 7, 1891.

Financial statements for works of improving the Mississippi River between Minneapolis and St. Paul during the season of 1891.

Amount expended in the field during the calendar year (including $1,329.77 liabilities outstanding December 31, 1891)	$23,853.71
Add quota of general superintendence and office expenses (including $4.25 liabilities outstanding December 31, 1891)	835.33
Add for use and deterioration of plant	1,899.53
Total	26,588.57

The following statements show the cost of the different classes of work accomplished.

REMOVING BOWLDERS.

Amount expended in the field during the calendar year	$8,393.54
Add quota of general superintendence and office expenses	293.93
Add for use and deterioration of plant	820.41
Total	9,507.88
Bowlders removed ... solid cubic yards	1,230.2
Average cost per cubic yard for field expenses	$6.823
Average cost per cubic yard for general superintendence and office expenses	.239
Average cost per cubic yard for plant	.667
Average cost per cubic yard of bowlders removed	7.729

BANK REVETMENT.

Amount expended in the field during the calendar year	$9,259.33
Deduct for labor of unloading gravel at Minnehaha	148.16
Net cost of field work	9,111.17
Add quota of general superintendence and office expenses	324.25
Add for use and deterioration of plant	1,079.12
Total	10,514.54
Material put in works:	
Rock ... cubic yards	5,376.7
Gravel ... do	177.8
Brush ... do	4,917.7
Total ... do	10,472.2
Average cost per cubic yard on barges	.373
Average cost per cubic yard for towing and putting in material	.497
Average cost per cubic yard for general superintendence and office expenses	.031
Average cost per cubic yard for plant	.103
Average cost per cubic yard in place	1.004

DREDGING GRAVEL BARS.

Amount paid contractor	$6,027.71
Deduct expense of removing piers and snags	203.33
Net cost of dredging gravel bars	5,824.38
Add cost of local inspection	173.13
Add quota of general superintendence and office expenses	217.15
Total cost of dredging	6,214.66
Material dredged ... cubic yards..	30.322
Average cost per cubic yard dredged	.205

ST. PAUL TO PRESCOTT.

Dams and shore protections.—Under a project presented February 23, 1891, and approved February 28, 1891, alloting $40,000 for improving the Mississippi River between St. Paul and Prescott, work was carried on by day's labor and use of Government plant, materials being purchased in open market.

The United States towboat *Fury* and launch *Bessie* were used for towing materials.

On July 10, 1891, the construction of dams was begun at Nininger to complete and preserve the permanent channel started June 1, 1891, by the dredge *Phœnix*. Dams 34, 35, 36, 37, 38, 39, and 40 (sheet 5), and Dam 15 (sheet 6) were built; Dams 7, 26, 27, 30, 31, and 32 (sheet 5), and Dam 4 (sheet 6) were lengthened, and Dam 7 (sheet 5) was also raised. Dams 34, 35, 36, and 40 (sheet 5) are wing dams, extending from the right bank at Nininger; Dams 37, 38, and 39 (sheet 5) are wing dams, extending from the left bank below Dam 27 (sheet 5); Dam 15 (sheet 6) is a low wing dam, extending from the bar between Dams 4 and 5 (sheet 6), and is 2.5 feet above low water of 1864. All the other dams are 4.5 feet above low water. This work was completed July 31.

The fleet was taken to St. Paul Park on August 1, on which date work was commenced in this vicinity. At this time the river here was in a very bad condition, the water being at a low stage, and spread over a long reef, extending diagonally across the river, through which there were three shoal and indistinct channels. Dams 31, 32, 32½, 33, and 34 (sheet 3) were built, and Dam 16 (sheet 3) was raised and lengthened. Dam 31 extends from the foot of Island 5; Dams 32, 32½, and 33 extend from Island 6; Dam 34 is built from the lower end of the bar extending from the foot of Island 6. The left bank opposite Island 6 was protected for a distance of 815 feet.

On October 22 the protection of the bank of Island 16 was begun, work of bank revetment between Minneapolis and St. Paul having been suspended and the crew transferred to this place for operation during the balance of the season. The launch *Bessie* did the towing for this work. This protection is of the usual construction of rock and brush, and extends downstream from Dam 2 (sheet 5); length, 2,200 feet; width, 35 feet. It should be continued several hundred feet farther downstream, and a slight addition of rock should be made in places where it was not quite finished. Owing to cold weather this work was discontinued November 16.

On November 4, after suspension of operations between Prescott and Lake Pepin, the fleet was transferred to Hastings, where the protection of the left bank of the river was begun the same day. This revetment extends upstream from the ferry landing, and is 1,300 feet long and 40 feet wide. This protection should be continued upstream several hundred feet, and more rock should be added over the entire length, as but a light covering was put on the bank owing to lack of material. Work was discontinued at Hastings November 12, and the fleet and crew were moved to Island 18, to assist in work at that place. While moving the fleet up river the crew made small repairs to the shore protection at Franklin Coulee.

November 13 the towboat *Fury* with Barge No. 6 started for the Des Moines Rapids Canal for use during 1892. Being overtaken by cold weather, they were placed in winter harbor at Kahlke's boat yard, at Rock Island, Ill.

Operations for the season were suspended November 16, owing to cold weather, and the fleet was laid up in winter harbor at Boulanger Slough.

Materials were purchased in open market loaded on United States barges, the prices, fixed by competition, being as follows: Rock, 42½ cents and 44 cents per cubic yard; brush, 18¾ cents, 19¾ cents, 21¼ cents, 23 cents, and 25 cents per cubic yard; poles, 2½ cents and 2¾ cents each.

Works of improvement should be constructed during the season of 1892 at the following places: A dam above Dam 13 (sheet 2), dams below Dam 28 (sheet 2), dams from Islands 4 and 5, dams in the vicinity of Grey Cloud Landing, dams above and below Hastings; the revetments opposite Island 1, below Newport, below Pine Bend, at head of Island 18, and opposite Hastings should be extended; repairs

should be made to the dams at Island 1, dams opposite Newport, shore protection above, and dams opposite Robinsons Rocks.

Dredging.—The United States towboat *J. G. Parke*, with dredge *Phœnix* and outfit arrived at Nininger, Minn., June 1, 1891, where the opening of a permanent channel was then begun. Owing to the condition of the river at this place, and in order not to interrupt navigation, it was necessary that this new channel be opened before the construction of dams was resumed, they being designed to cross the channel, which was at this time close to the right bank. Through the bar opposite Nininger a channel, 100 feet wide and 1,600 feet long, was dredged. This work was completed July 23. From July 24 to 27 the dredge was employed removing from the channel rocks thrown in from the quarries at Nininger. From July 28 to August 5 the dredging plant lay at Hastings while building a new dipper handle.

During the progress of dam construction at St. Paul Park a large body of sand was set in motion on the bar by the increased current, due to confining the water to narrower limits, making a temporary shoaling in the already shallow channel. In order to keep the channel navigable, it became necessary to employ a dredge for a few days to assist in the movement of this sand. The dredging plant of Mr. C. H. Appleton, then working under agreement below Minneapolis, was moved to this place. On August 11 dredging was begun above Dam 25 (sheet 3). A channel 400 feet long and 100 feet wide was dredged through the bar. This cut was completed August 19. The cost of this dredging was $760.67; the rate of pay was $8 per hour for the dredging plant while in operation.

From November 7 to 12, inclusive, the dredging plant of Mr. Appleton was employed removing snags from the channel between St. Paul and Prescott, advantage being taken of the dredging plant at hand—operations having ceased below Minneapolis—and of the very favorable low stage of water, which made it possible to readily find the sunken snags. The dredge removed 55 snags. The cost of the work was $355.33, being at the rate of $8 per hour, and was paid from the appropriation for "operating snag boats and dredge boats on Upper Mississippi River." In addition to the snags removed by the dredge, a small party, using one of the derrick barges with grappling hooks brought from the Minneapolis works, removed 15 snags in the vicinity of Nininger and Hastings. The towboat *Fury* also pulled 30 snags during the season between St. Paul and Prescott.

List of works constructed and repaired and of materials used during the season of 1891 between St. Paul and Prescott.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 3:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 31	570	3.5	423.0	1,380.6
Dam 32	275	4.0	322.7	772.6
Dam 32½	300	4.0	376.0	1,176.1
Dam 33	160	3.5	249.1	845.3
Dam 34	150	3.5	206.2	730.5
Dam 16, raised and extended	30	3.5	257.0	598.8
Revetment opposite Island 6	815	....	712.4	582.0
Sheet 5:				
Dam 34	130	4.5	218.9	596.9
Dam 35	290	4.5	323.4	1,085.4
Dam 36	480	4.5	358.9	984.4
Dam 37	270	4.5	282.3	567.9
Dam 38	230	4.5	239.5	468.5
Dam 39	110	4.5	211.4	559.1
Dam 40	65	4.5	161.4	289.8
Dam 7, raised and extended	130	4.0	298.9	646.6
Dam 26, extended	35	4.5	124.3	200.4
Dam 27, extended	35	4.5	145.6	300.0
Dam 30, extended	65	4.5	184.1	426.4
Dam 31, extended	35	4.5	149.7	390.3
Dam 32, extended	20	4.5	125.0	308.3
Revetment, Island 18	2,200	....	2,234.1	1,378.7
Sheet 6:				
Dam 15	310	2.5	140.3	483.0
Dam 4, extended	50	4.0	123.0	245.9
Revetment opposite Hastings	1,300	....	1,557.1	1,087.5
Revetment Franklin Coulee, repaired	....	....	41.7	....
			9,466.0	16,105.0
Add for poles put in works			....	900.8
Materials put in works	....	....	9,466.0	17,005.8

Financial statements for works of improving Mississippi River between St. Paul and Prescott during the season of 1891.

DAMS AND REVETMENTS.

Amount expended in the field during the calendar year 1891 (from distribution sheets)		$21,897.46
Add cost of materials from 1890		505.78
		22,403.24
Deduct for material on hand at close of season	$393.28	
Deduct for labor of removing rocks	117.50	
Deduct expense of dredging channels	4,413.43	
		4,924.21
Net cost of field work		17,479.03
Add quota of general superintendence and office expenses		769.29
Add for use and deterioration of plant		1,782.68
Total cost of work		20,031.00
Material put in works:		
Rock ... cubic yards		9,466.0
Brush ... do		17,005.8
Total ... do		26,471.8
Average cost per cubic yard on barges		$0.286
Average cost per cubic yard for towing and putting in material		.375
Average cost per cubic yard for general superintendence and office expenses		.029
Average cost per cubic yard for plant		.067
Average cost per cubic yard in place		.757

DREDGING PERMANENT CHANNEL AT NININGER, MINNESOTA (GOVERNMENT PLANT).

Amount expended in the field during the calendar year 1891 (from distribution sheets)	$3,632.76
Deduct expense of removing rocks	224.33
Net cost of field work	3,408.43
Add quota of general superintendence and office expenses	159.84
Add for use and deterioration of plant	1,551.85
Total	5,120.12
Material dredged:	
Cast ... cubic yards	8,700.0
Loaded on scows, towed away, and dumped ... do	30,435.0
Total ... do	39,135.0
Average cost per cubic yard dredged	$0.131

DREDGING TEMPORARY CHANNEL AT ST. PAUL PARK, MINNESOTA (HIRED PLANT).

Amount paid contractor	$760.67
Add cost of local inspection	20.00
Add quota of general superintendence and office expenses	34.34
Total cost of work	815.01
Material dredged:	
Cast ... cubic yards	1,403.0
Loaded on scows, towed away, and dumped ... do	4,228.6
Total ... do	5,631.6
Average cost per cubic yard dredged	$0.145

PRESCOTT TO LAKE PEPIN.

Dams and revetments.—This work was carried on by days' labor and use of Government plant, under a project, presented February 23, 1891, and approved February 28, 1891, allotting $10,000 for improving the Mississippi River between Prescott and the head of Lake Pepin.

The towboat *Fury* and fleet were transferred to Island 21 on September 24, 1891.

The bar at Island 21 is known as "Wharfboat Bar," from the fact that during the low water of 1864 a wharf boat was placed there for use in transferring the freight to very light-draft boats—drawing about 13 or 14 inches when loaded—which it became necessary to use between that point and St. Paul, 34 miles above. These light-draft boats often had trouble in getting to St. Paul, on account of the low water during that year. While the river during the season of 1891 was the lowest ever reached since 1864, and in some places even lower than in 1864, there was no time during the past season (excepting a few days, when a temporary shoaling, due to dam construction, was made on the bar at St. Paul Park) when there was a less depth than 3 feet in the channel between St. Paul and Prescott. There was a depth of 3 feet at Wharfboat Bar, but the channel was so narrow and crooked as to be troublesome to navigation. This bar has been giving more or less trouble during the past three years and was constantly growing worse.

In this vicinity Dams 6, 7, 8, 9, 10, 11, and 12 (sheet 8) were constructed. Dam 6 extends from the foot of Island 20; Dams 7 and 8 extend from the head and foot, respectively, of Island 21; Dams 9, 10, and 11 extend from the right bank below Island 21; Dam 12 is a closing dam, from the Minnesota shore to Island 21.

Operations at this place were suspended November 4, when the plant was transferred for work between St. Paul and Prescott.

The materials were purchased in open market, at prices fixed by competition. The cost of materials per cubic yard, loaded on United States barges, was as follows: Rock, 42½ and 44 cents; brush, 18¾ cents, 19¾ cents, 21¼ cents, and 25 cents; poles, 2½ cents and 2¾ cents each.

Works of improvement should be continued during the season of 1892 at the following places: Extension of the series of dams at Island 21; continuation of the revetment below Island 19; protection of the right bank below Morgan Bar, below Sturgeon Slough, and opposite Island 23; protection of the left bank above and below Redwing. The construction of dams from the left bank below Prescott may become necessary. This place has been growing more troublesome for several years, and during 1891 only a very poor channel existed. This very large bar should be controlled as soon as practicable.

Dredging.—On August 5, 1891, the United States dredge *Phœnix* and outfit were moved from Hastings, the dipper-handle being finished, to the bar below Island 21, where the channel was not only shoal, but narrow and crooked. A temporary channel was dredged near the left bank. The material from the first cut was cast into a bank near the shore; all of the other material excavated was removed in scows and deposited out of the way. Work was completed August 17, when the dredging plant started down the river for work at various points. The channel excavated is 950 feet long and 90 feet wide. The opening of this channel greatly facilitated navigation during the remainder of the season, and also made it possible to begin the construction of dams in the vicinity of Island 21, which work was undertaken September 25. This dredging was carried on under the appropriation for "operating snag boats and dredge boats on Upper Mississippi River."

A list of works constructed and of materials used during the season of 1891 between Prescott and Lake Pepin.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 8:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 6	135	3.5	226.2	411.0
Dam 7	200	3.5	285.3	446.2
Dam 8	240	3.5	368.8	692.0
Dam 9	760	3.5	1,082.8	1,968.7
Dam 10	710	4.0	1,353.5	2,155.4
Dam 11	650	4.0	1,559.3	1,614.0
Dam 12	425	4.0	575.9	1,034.8
			5,451.8	8,322.1
Add for poles put in works				309.6
Materials put in works			5,451.8	8,631.7

Financial statement for works of improving Mississippi River between Prescott and Lake Pepin during the season of 1891.

DAMS AND REVETMENTS.

Amount expended in the field during the calendar year 1891 (from distribution sheets)	$8,234.98
Add quota of general superintendence and office expenses	362.34
Add for use and deterioration of plant	1,040.17
Total cost of work	9,637.49
Material put in works:	
Rock ... cubic yards	5,451.8
Brush ... do	8,631.7
Total ... do	14,083.5
Average cost per cubic yard on barges	$0.294
Average cost per cubic yard for towing and putting in material	.294
Average cost per cubic yard for general superintendence and office expenses	.025
Average cost per cubic yard for plant	.074
Average cost per cubic yard in place	.687

SURVEYS AND GAUGES.

Between Minneapolis and Lake Pepin.—A water surface at a low stage was taken between Minneapolis and Redwing. Between Minneapolis and St. Paul the levels were referred to the bench marks established during the survey of that part of the river made in 1877. Between St. Paul and Prescott the water surfaces were referred to established bench marks, and a continuous line of levels was run from St. Paul to Pine Bend to check former levels. From Prescott to Redwing, duplicate lines of levels were run, with which the water surfaces were connected. Numerous permanent bench marks were established between Minneapolis and Redwing.

The water surfaces were taken August 19, 1891, between Prescott and Redwing; and on October 2, 1891, between Minneapolis and Prescott.

The cost of the work above mentioned, exclusive of general superintendence and office expenses, was $395.67.

* * * * * * *

READS TO MINNEISKA.

Work in this locality, consisting of the construction and repair of brush and rock dams and shore protections, was carried on under contract, in accordance with project approved January 6, 1891. The amount of the allotment was $50,000. On completion of his contract, the contractor, Mr. Jacob Richtman, was authorized to continue operations, under a further allotment of $20,000, at the same prices as were formerly paid him. The prices paid for material in place were, for rock $1.20 per cubic yard, and for brush 27 cents per cubic yard.

The following extracts are made from the report of Mr. W. A. Thompson, superintendent in local charge:

"Mr. Richtman commenced work May 16 on repairing the dams near the mouth of the Zumbro River. For many years boats and rafts have experienced great trouble during low stages of water in the vicinity of Beef Slough, especially where the Mississippi River Logging Company have their boom for sheering logs into West Newton Chute, and in the vicinity of Island No. 34, or what is known as Little Beef Slough. At the latter place, for several years prior to 1889, the steamboat channel was across the head of and down the east side of the island, it being a narrow and very difficult channel for boats and rafts to follow. In 1889 it was found possible for boats and rafts to go on the west side of the island; but in low stages of water boats often grounded, causing long delays and great expense to steamboat owners. To hold and improve this new channel, Mr. Richtman was instructed to build a dam across Little Beef Slough and to protect the west side of Island No. 34 and Island 35 from opposite the foot of Island 34 downstream a distance of 3,420 feet. The head of Island No. 33 was also protected.

"Since the completion of this work, though the river was as low as in 1864, no trouble has been experienced by navigators in this part of the river.

"To improve the channel near the boom above West Newton Chute, a wing dam (No. 32, sheet 14), from the right bank between the old wing dams 12 and 13 (sheet 14), was constructed, thereby confining the water to a narrower space and materially deepening the channel around the boom, but a good channel will probably

never be maintained here, with the present boom in operation, without the aid of a dredge during low stages of water.

"The shore protection of Islands 36, 37, 38, and 39, and Dam 16 (sheet 14), near mouth of Beef Slough, were thoroughly repaired.

"August 15 the fleet was moved to Island 42, about 2 miles below Alma, where a rapidly caving bank was protected for a distance of 920 feet.

"August 19, the fleet was moved again to West Newton Bar, above the head of Pomme de Terre Chute. There has been much trouble at this bar for many years and, to confine the river to one channel down the east bank, two wing dams were built from the right bank. Three short wing dams were built near the head of Pomme de Terre Chute to straighten the channel past the head of Island 46. The left bank above Pomme de Terre Chute was protected for a distance of 3,226 feet. Wicker Slough was also closed and the old shore protection on head of Island 46 was repaired. The right bank below West Newton Chute, which was caving badly, was protected for a distance of 1,676 feet.

"Work on this part of the river was suspended November 12 on account of cold weather.

"Mr. A. J. Stibolt, the local inspector, gave excellent satisfaction.

"A list of works constructed and repaired, and of materials used during the season of 1891 between Reads and Minneiska.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 14:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 31	700	3	2,305.4	1,909.3
Dam 32	1,300	4	2,854.5	2,562.8
Dam 9, repaired			171.9	
Dam 11, repaired	40	4	551.5	268.8
Dam 15, repaired			42.9	
Dam 16, repaired			218.8	133.7
Dam 17, repaired	30	4	344.4	77.7
Dam 18, repaired	90	4	645.6	286.4
Shore protection, Island 33	850		1,216.9	881.3
Shore protection, Island 34	1,150		1,961.4	758.1
Shore protection, Island 35	3,420		6,153.5	3,453.4
Shore protection, Island 36	400		537.1	396.4
Shore protection, Island 37	350		414.6	290.1
Shore protection, Island 38	2,270		3,412	2,041.2
Shore protection, Island 39	1,580		2,581.1	1,556.4
Sheet 15:				
Dam 7	575	2.5	1,703.4	1,769.4
Dam 8	250	4	858.3	751.9
Dam 9	550	4	2,174.9	1,959
Dam 10	300	4	1,639.6	1,280.5
Dam 11	80	4	511.2	346.6
Dam 12	550	2.5	1,444.1	1,674.3
Dam 13	60	4	99.1	44
Dam 1, repaired			790.7	746.9
Dam 6, repaired			212.4	64
Shore protection, Island 42	920		1,577.4	976.2
Shore protection, Island 46	600		1,136.9	574.5
Shore protection opposite Dam 7	3,226		5,052.1	3,347.6
Shore protection below West Newton Chute	1,676		2,800.7	1,910.4
Materials put in works			43,412.4	30,060.9

* * * * * * *

Financial statement for work between Reads and Minneiska, performed under contract and agreement during season of 1891.

Amount paid contractor	$60,211.32
Cost of local inspection, etc	1,409.10
Add quota of general superintendence and office expenses	2,717.38
Total	64,337.80
Material put in works:	
Rock ... cubic yards	43,412.4
Brush ... do	30,060.9
Total ... do	73,473.3
Average cost per cubic yard in place	$0.876

MINNEISKA TO LA CROSSE.

The project for improvement by construction of dams and shore protections in this stretch of river, 52 miles in length, was approved February 28, 1891. Work during the season, under an allotment of $60,000, was performed by hired labor and use of Government plant, the *Alert* and launch *Ada* being employed for towing. The material, excepting a small quantity of brush and poles cut and loaded by United States laborers, was purchased in open market, at prices ranging from 33 to 55 cents per cubic yard for rock, and 20 to 26 cents per cubic yard for brush, these prices being for materials loaded on Government barges. The principal part of the rock used was a soft sand rock, obtained at 40 cents per cubic yard loaded on Government barges. This rock, if carefully handled, forms a good substitute for the harder lime rock hitherto chiefly used, and costs about one-third less. It hardens under water and on exposure to air, as is shown by experience with small quantities of it in former years.

The following extract comprises the greater part of the report of Mr. W. A. Thompson, superintendent in local charge of operations:

"May 27, the towboat *Alert* was taken out of the Des Moines Rapids Canal, where it had been since November, 1889, and run to Rock Island. May 29 the *Alert* left Rock Island with three new flatboats loaded with coal. Arrived at Fountain City, Wis., June 3. June 4 the barges, quarter boat, pile-driver, etc., that had been in Fountain City Bay during the previous winter, were put in commission.

"The first work done was the protection of the head and a part of the east side of Island No. 49, below Minneiska. This island is composed of a soft, sandy material, and for the last two years has been cutting and caving rapidly. After the completion of this work the construction of two wing dams from the left bank above Island No. 50 was commenced. This work was very necessary to straighten the channel at and above the island, which channel for two years had been very crooked and close to the head of the island; so close, in fact, that if pilots did not exercise the greatest care their rafts would be driven onto the head of the island and broken up. The old closing dam (1, sheet 16), east of Island No. 50, was raised to 4 feet above low water of 1864, and the old shore protection on head of Island 50 was thoroughly repaired. This work was completed the last of June, and there has been no trouble in this part of the river since.

"A few minor repairs to dams and shore protection above Fountain City were made.

"All of the rock used for the above work was furnished by A. Kirchner at Fountain City. All of the brush left over from season of 1890 was used and the remainder was furnished by C. Masueger.

"July 5, the fleet was moved to head of Island No. 88 or Crane Island, below Trempealeau, Wis.

"The river from Trempealeau to Queens Bluff, a distance of about 5 miles, has been very bad for many years. A wing dam from left bank about a mile below Trempealeau and a closing dam east of Island 87 were built in 1887. These dams helped matters a little in their immediate localities, but a general improvement of this part of the river was not commenced, in the hope that the steamboat channel would be through Richmond Chute; but as this desired object could not be obtained it was decided in the project approved this year to enter upon a system of channel improvement to the east of Richmond Island and close up Richmond Chute entirely.

"As the closing of Richmond Chute would force a large volume of water down the east side of Richmond Island, it was decided best to put the banks at Crane Island and the upper side of Richmond Island in condition to withstand the increased current and volume of water. The first work done was to protect the head of Crane Island; then the shore at head of Richmond Island was protected; then a dam was built across the chute east of Crane Island; after which the closing of Richmond Chute was commenced. After two courses of brush and rock had been put in this dam, work was temporarily suspended, August 3, and the fleet taken to Dakota Bar, about 1 mile below Dakota, Minn. This bar had, for the time being, become the head of navigation for the larger boats, the river at this time being as low as has been known since any record had been kept by the Government, and, besides, no work having ever been done to improve this part of the river. On examination of this bar it was found to extend from the foot of Island No. 92, quartering downstream to below Island No. 94. About the same depth of water (3 feet, scant) was found on the reef for its whole length of about 1 mile.

"The first work done was to build a wing dam, 360 feet long, from about the middle of the west side of Island No. 93. Then another wing dam, 635 feet long, from the lower end of Island No. 93, was built that extended well out onto the reef. The chute east of Island No. 93 was closed by a dam. Two low wing dams were built from the Minnesota shore, nearly opposite the dams on west side of Island No. 93, across the deep water out to the reef, thus confining the river to a much narrower

channel. Since the construction of these dams no trouble has been experienced by navigators at this point.

"August 24, the fleet was taken below the Lacrosse Railroad Bridge. Four low wing dams were built from left bank and across the deep-water channel down the shore above Island No 105. The shore protection opposite Lacrosse was repaired, and the gap in the closing dam west of Broken Arrow Island was filled up.

"September 1, the fleet was moved back to Richmond Island and work was resumed on the dam across Richmond Chute. After this dam was completed the east side of Richmond Island was protected a distance of 1,488 feet from its head. Two wing dams were built from right bank above Richmond Chute. A wing dam 1,400 feet long was built from left bank, midway between Island No. 87 and old Wing Dam No. 7 (sheet 18). Two wing dams, one from the head and one from the foot of Island No. 87, were built. Two wing dams from left bank above Crane Island Chute were built, and the east side of Island No. 84 was protected.

"On account of cold weather work was suspended November 13.

"While the work in the vicinity of Richmond has resulted in a great benefit to navigation, it is desirable that more work should be done as soon as possible, as a wing dam from the left bank, about 800 feet below the foot of Island No. 87, should be built, and more of the east side of Richmond Island should be protected.

"Nearly all the rock used in the work in the vicinity of Richmond, Dakota, and Lacrosse, was sand rock quarried near the head of Richmond Chute. It is much easier quarried and handled than lime rock, and I believe it to be nearly as durable. It cost the Government 20 cents per cubic yard less than lime rock.

"The fleet was laid up in Fountain City Bay November 14.

List of works constructed and repaired, and of materials used, during the season of 1891, between Minneiska and Lacrosse.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 16:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing Dam 8	88	4	134.1	251.2
Wing Dam 9	400	4	1,389.7	1,846
Wing Dam 10	250	4	997	2,182.2
Closing Dam 1, repaired		4	590.1	1,261.8
Closing Dam 7, repaired		4	80.2	389.4
Shore protection, Island 49	1,520		1,770.4	1,572.4
Shore protection, Island 50	200		299.8	200.5
Sheet 17:				
Shore protection, Island 61, repaired			204.5	608.6
Sheet 19:				
Closing Dam 8	753	4	4,646.5	4,877.5
Closing Dam 9	775	4	5,297.1	5,134.6
Wing Dam 10	1,400	3	2,293.5	2,953.1
Wing Dam 11	1,084	3	1,274	1,807.3
Wing Dam 12	465	3	1,338.1	759.8
Wing Dam 13	625	3	1,234.4	1,345.7
Wing Dam 14	352	4	689.9	1,225.1
Wing Dam 15	1,250	3	2,061.8	2,487.8
Wing Dam 16	765	3	1,043.8	1,123.1
Shore protection, Island 84	600		1,684.1	811.1
Shore protection, Island 86	1,488		3,377.3	1,659.2
Shore protection, Island 88	1,450		3,088.5	1,378.1
Sheet 20:				
Wing Dam 4	360	1.5	496.6	1,003
Wing Dam 5	635	1.5	283.3	529.5
Closing Dam 6	465	1.5	801.9	1,292
Wing Dam 7	308	—3	1,049.6	1.328.9
Wing Dam 8	361	—3	639.2	1,579.8
Sheet 21:				
Wing Dam 5	146	—3	209.6	341.6
Wing Dam 6	159	—3	289.2	387.4
Wing Dam 7	196	—3	419.5	551.6
Wing Dam 8	310	—3	561.3	343.2
Shore protection, Grand Island, repaired			71.3	
Sheet 22:				
Closing Dam 1, repaired			140.4	181.1
Materials put in works			38,456.7	41,412.6

In the above table, 3,481 poles, equal in volume to 348.1 cubic yards, are included in the item of brush.

Financial statement for work between Minneiska and Lacrosse, performed by hired labor during season of 1891.

Amount expended in the field during the calendar year 1891 (from distribution sheets)	$44,717.13
Add cost of materials paid for in 1890	452.17
Net cost of field work	45,169.30
Add quota of general superintendence and office expenses	1,970.55
Add for use and deterioration of plant	4,200.04
Total	51,339.89
Material put in works:	
Rock ... cubic yards	38,456.7
Brush ... do	41,412.6
Total ... do	79,869.3
Cost of material on barges	$24,949.41
Average cost per cubic yard on barges	$0.312
Average cost per cubic yard for towing and putting in material	.253
Average cost per cubic yard for general superintendence and office expenses	.025
Average cost per cubic yard for plant	.053
Average cost per cubic yard in place	.643

* * * * * * *

VICINITY OF LACROSSE AND CROOKED SLOUGH.

To provide for emergency work between Lacrosse and Keithsburg, the sum of $10,000 was allotted, under project approved February 28, 1891, for purchase of material to be used at different localities. It was thought that considerable repairs might be needed to works in this division of the river constructed in former years, and that, perhaps, by building a short piece of shore protection or closing a small slough here and there, much good might be done. It was proposed to put the material in place by means of the snag boats and their crews, their expenses to be borne by the appropriation for operating snag boats and dredge boats on Upper Mississippi River, such work having often been performed by these boats and having always been included in snag-boat projects. Work was performed in two localities—in vicinity of Lacrosse, and at Crooked Slough.

Vicinity of Lacrosse.—From July 29 to August 17 the crew of the *General Barnard* was employed in the construction of 1,115 lineal feet of shore protection at left bank above Taylors Island (105); of a short dam across cut-off at Bates Island (104), and in making repairs to existing shore protections at Taylors Island and Grand Island (106). The material was brought to the work by towboat *Alert* and launch *Ada*, four barges being also used. The amount of material put in at this locality was 1,830.7 cubic yards of rock and 1,025.4 cubic yards of brush. The rock used was a sand rock and cost 40 cents per cubic yard on barges. The brush was obtained for 20 cents per cubic yard on barges.

At Crooked Slough.—From October 5 to 25 the *General Barnard's* crew was employed in construction work at Crooked Slough. At this locality, as the banks were caving rapidly, 1,183 linear feet of shore protection were built, and needed repairs were made to shore protections at several points in the slough. From the 5th to the 15th the towing was done by launch *Elsie*, but as her shaft was broken on the latter day and could not be immediately repaired, the remainder of the towing was performed by the *General Barnard*. On October 25 the four barges used in the work were turned over to towboat *Alert* at Genoa. The amount of material put in at Crooked Slough was 2,613.6 cubic yards of rock and 1,341.3 cubic yards of brush. The prices paid for material were 60 cents per cubic yard for rock and 20 cents per cubic yard for brush, these prices being for materials delivered on Government barges.

List of works constructed and repaired, and of materials used by crew of snag boat General Barnard, during season of 1891, at vicinity of Lacrosse and Crooked Slough.

Designation.	Length.	Material: Rock.	Brush.
Sheet 21:	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam closing cut-off at Bates Island	273	288.5	406.5
Shore protection of left bank above Taylors Island (new)	1,115	1,146.9	568.9
Shore protection at Taylors Island, repaired		111.5	50
Shore protection at Grand Island, repaired		257	
Sheet 22:			
Dam 1, repaired		76.8	
Sheet 23:			
Dam 2, repaired		71.3	30.9
Dam 3, repaired		115	32.4
Shore protection below Dam 3 (new)	1,183	1,856.6	1,101
Shore protection below Dam 3, repaired		478	177
Shore protection at head of Crooked Slough, repaired		92.7	
Materials put in works		4,444.3	2,366.7

The cost of above work to appropriation for "improving Mississippi River from Minneapolis to Des Moines Rapids," including quota of office expenses, was $3,525.86.

Approximate statement of cost of work performed by crew of snag boat General Barnard, during season of 1891, at vicinity of Lacrosse and Crooked Slough.

Material and sundry expenses	$3,377.27
Quota of general superintendence and office expenses	148.59
Charge for use of plant	334.56
Pay and subsistence of crew of *General Barnard,* about	2,065.00
Fuel for steam launch, etc., about	240.00
Total	6,165.42

Material put in works:		
Rock	cubic yards..	4,444.3
Brush	do....	2,366.7
Total	do....	6,811.0

Average cost per cubic yard in place, $0.905.

EAST CHANNEL AT PRAIRIE DU CHIEN.

This work was carried on during the season with a special allotment of $30,000, provided for in act of September 19, 1890, and in accordance with project approved January 8, 1891. From the project referred to I make the following extracts: "An examination of the locality was made September 24 and 25, 1890, and the accompanying tracing gives the results of the survey and shows in red the works proposed. The river is divided, in the vicinity of Prairie du Chien, by an island, forming two channels. The one along the Iowa shore by McGregor is the most direct and deepest, and is used by all rafts and by all boats which have no business to transact at Prairie du Chien. The channel on the Wisconsin shore by Prairie du Chien is now comparatively shallow, with but little current, and there are two serious points of obstruction; the one about one-third of a mile above the railroad pontoon bridge, and the other a little below the elevator. * * * It appears that a sufficiently deep channel of a greater width than 500 feet can not well be projected for the Prairie du Chien side without endangering the other channel; but such width of 500 feet will furnish most ample accommodation for all boats which may desire to run to the east of the island. For the formation and preservation of a good channel 500 feet in width, a series of wing and closing dams has been projected and is shown on the accompanying map in red. * * * The amount of money now available for this work will not construct all the dams projected, and it is not probable that all such dams will be immediately necessary, it being proposed to construct such of the dams as will have the greatest influence on the two worst points of obstruction herein referred to and which may appear most important at time of construction. The dams are to be of similar form and construction to those heretofore built on the Upper Mississippi River and will have their crests at an elevation of about 4 feet above low

water. It is proposed to perform the work of improving the Prairie du Chien channel under formal written contract after advertising in the usual manner."

After due advertisement the contract for the work at Prairie du Chien was let to Patterson Bros., of Keokuk, Iowa, at 90 cents per cubic yard for rock in place and 40 cents per cubic yard for brush in place. Operations were commenced May 23 and completed October 3. The work was much delayed by the very low stage of water prevailing during the summer, and great difficulty was experienced in procuring material owing to scarcity of men. Most of the dams laid down on the map accompanying the project were constructed, and the channel at close of season appeared to be somewhat better, but considerable time must elapse before the improvement expected may result.

Mr. C. A. Stoddard was the local inspector and gave excellent satisfaction.

List of works constructed and of materials used during the season of 1891, at East Channel, Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 30:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 1, closing	80	4.0	570.3	392.6
Dam 2, closing	336	2.0	1,812.2	1,902.1
Dam 3, closing	161	—2.5	983.4	859.0
Dam 4, wing	406	4.0	924.4	931.8
Dam 5, wing	288	4.0	773.8	1,055.6
Dam 6, wing	611	4.0	1,596.5	1,526 7
Dam 7, wing	281	4.0	962.9	1,081.0
Dam 8, wing	1,000	4.0	2,130.1	2,186.4
Dam 9, wing	750	4.0	2,122.3	2,141.6
Dam 10, wing	700	4.0	1,803.4	2,056.6
Dam 11, wing	500	4.0	1,300.4	1,314.7
Dam 12, wing	295	4.0	875.9	895.0
Dam 13, wing	560	4.0	1,440.3	2,030.7
Dam 14, wing	445	4.0	1,151.8	1,609.9
Dam 15, wing	706	4.0	1,325.8	1,514.6
Materials put in works			19,773.5	21,498.3

Financial statement for work at East Channel, Prairie du Chien, performed under contract during season of 1891.

Amount paid contractors	$26,395.47
Cost of local inspection, etc	837.12
Add quota of general superintendence and office expenses	*1,197.88
Total	28,430.47

Material put in works:		
Rock	cubic yards	19,773.5
Brush	do	21,498.3
Total	do	41,271.8
Average cost per cubic yard in place		$0.689

The work at Prairie du Chien now forms a part of the work for improvement of through navigation of the Upper Mississippi River, and can be cared for under general appropriations. For this reason authority has been granted to transfer the balance of this allotment, $1,569.53, to allotment for general improvement of Mississippi River from Minneapolis to Des Moines Rapids.

CASSVILLE SLOUGH.

About 3 miles below Glenhaven, at the foot of the bluffs, was a bad, square channel crossing, which has been gradually becoming shoaler for several years. During the low water of 1891 the depth on the reef was but 3 feet, and great trouble was experienced by boats and rafts in getting over. This crossing was especially trou-

* Of this amount, $450 are liabilities paid in January, 1892.

blesome to rafts, on account of the nearness of the reef to the Wisconsin shore, which made it very difficult for them to pass without striking; and, in fact, many of them did strike the bank and were more or less damaged.

Under project approved October 13, 1891, an agreement was made with Patterson Bros. to perform the required work of building dams and shore protection, at $1.20 per cubic yard for rock in place and 50 cents per cubic yard for brush in place. Operations were begun October 12 and came to an end November 2.

A wing dam, 625 feet in length, was built out from Island 189, below the crossing, and a submerged dam, 135 feet in length, extended from the Wisconsin shore nearly opposite, the latter running across the deep water. The channel was at once improved as to depth, but some difficulty was still experienced in making the short turn. It is hoped that by next season this difficulty will have passed away; but, it may be found to be necessary to remove a portion of the long dam by use of a dredge.

Mr. C. A. Stoddard was the local inspector.

List of works constructed and of materials used during the season of 1891 in Cassville Slough.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
Sheet 32:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 4, from Island 189	625	4	1,643.3	2,088.5
Dam 5, from Wisconsin shore	135	—3	806.9	1,231.8
Materials put in works			2,450.2	3,320.3

Financial statement for work at Cassville Slough, performed under agreement during season of 1891.

Amount paid contractors	$4,600.39
Cost of local inspection, etc	221.87
Add quota of general superintendence and office expenses	212.07
Total	5,034.33
Material put in works:	
Rock ... cubic yards	2,450.2
Brush ... do	3,320.3
Total ... do	5,770.5
Average cost per cubic yard in place	$0.872

BELLEVUE TO SAVANNA.

Under project approved January 6, 1891, and allotment of $25,000, contract was entered into with Patterson Bros. for the construction of brush and rock dams at 90 cents per cubic yard for rock in place and 38 cents per cubic yard for brush in place. No work was done in this locality during the season.

The time for completion of the contract has been extended to November 15, 1892.

VICINITY OF CLINTON.

The project, allotting $5,000 for construction of a dam and shore protection in vicinity of Clinton, was approved February 28, 1891, and work was carried on, by use of hired labor and Government plant, from May 18 to June 29. The prices paid for material, delivered on United States barges, were: Rock, 60 cents per cubic yard; brush, 20 cents per cubic yard, and poles 3 cents each. The work accomplished consisted in the construction of a small dam at the head of the guard fence, east channel; Dam No. 1 from Island 290 to Willow Island; and shore protection around head of Willow Island. Dam No. 1 is 750 feet long and has its crest at an elevation of 3 feet above low water. The shore protection on Willow Island is 600 feet in length.

The work was in local charge of Superintendent J. C. McElherne.

Financial statement for work in vicinity of Clinton, performed by hired labor during season of 1891.

Amount expended in the field during the calendar year 1891 (from distribution sheets)	$4,173.59
Add quota of general superintendence and office expenses	183.61
Add for use and deterioration of plant	464.12
Total	4,821.32
Materials put in works:	
Rock .... cubic yards..	2,589.6
Brush .... do....	2,902.8
Poles (1,525) .... do....	152.5
Total .... do....	5,644.9
Average cost per cubic yard on barges	$0.379
Average cost per cubic yard for towing and putting in material	.361
Average cost per cubic yard for general superintendence and office expenses	.032
Average cost per cubic yard for plant	.082
Average cost per cubic yard in place	.854

HARBOR AT PORT BYRON.

The act of September 19, 1890, made a special allotment of $5,000 for removal of bar at Port Byron, and a project for dredging in that locality was approved February 27, 1891, a modification of which project was approved June 20, 1891. The project called for the removal by dredging of a portion of the bar obstructing the upper landing. Work, under agreement with Mr. A. J. Whitney, was commenced June 6. The price agreed upon for the removal of material was 12 cents per cubic yard. Operations ceased November 12, and resulted in affording good landings from the coal chutes to foot of Cherry street.

Here follows the report of Mr. J. C. McElherne, superintendent in local charge:

* * * * * * *

"Dredging operations were begun at lower end of bar on June 6. The work was shaped so as to clean up well along the shore and at the same time carry the work of removal as wide and as far up the river as possible. On July 15 the dredge was taken away to do some work for the United States at Moline, and did not return until September 14. Relief being required by a lumber firm up river, the dredge was again transferred elsewhere on September 29 and failed to put in an appearance until October 13, from which time she remained at her post until the close, which occurred on November 12.

"The original project was to remove the material to a depth of 3 feet below low water of 1864; but the river fell and remained so low throughout the season that it was found necessary to excavate to 4 feet below low water in order that the dredge boat might have sufficient room to operate over the bottom. The worked area was carried to this depth up to a point on line with upper side of Cherry street, where it was made 100 feet wide and sloped out to deep water and down river for a distance of about 200 feet.

"Mr. J. W. Brackett, who acted as inspector on the work, attended to his duties faithfully."

* * * * * * *

Financial statement for dredging work at harbor at Port Byron, performed under agreement during season of 1891.

Amount paid contractor	$4,451.35
Cost of local inspection, etc	369.65
Add quota of general superintendence and office expenses	179.00
Total	5,000.00
Amount of sand dredged and removed .... cubic yards..	37,094.62
Average cost per cubic yard removed	$0.135

IMPROVING ROCK ISLAND RAPIDS.

This work was in local charge of Mr. J. C. McElherne, superintendent. Operations of the season commenced April 17, on which date and during the week following the fleet was towed from Rock Island to Hampton, but owing to high water active operations were not begun until May 18, the intervening time being occupied by a small force in staking out proposed work, establishing buoys, resetting and repainting range stakes, preparing quarters for the men, and in making needed repairs to the plant. Work was suspended November 20, and the fleet taken into winter quarters at Rock Island. Cold weather coming on suddenly, the fleet was in considerable danger before it was safely stored.

The work accomplished was the completion of rock excavation at Cabin Chain; the removal of dangerous patches at Moline, Duck Creek, and Winnebago Chains; the removal of bowlders at Duck Creek Chain; the construction of Guide-piers 4 and 9; and the building of Dams 3, 6½ and 7 (sheet 47).

The following extracts are made from Mr. McElherne's report:

* * * * * * *

"*Rock excavation.*—On May 16 the steam drill boat was moved to Cabin Chain, holes were drilled, and large flexible range poles were set up, completely outlining the full width of the channel from head to foot of the chain, a distance of 2,900 feet. This action was taken so that the drill boat could be kept within the required limits and operations be carried on intelligently and without much aid from the steam launch, which was at this time detached for other work. The drill boat began at the head of the chain, maneuvered carefully across the channel over sections 56 feet in width and shattered all elevations, both large and small, met with above grade until the lower end was reached. The drill boat was kept on correct lines by means of prominent ranges established on the adjacent shore. The high points and patches were often few and widely separated, necessitating long and tedious moving, a proceeding which could not be avoided without the probability of missing many hidden obstructions. On July 10, a section 118 feet wide and 500 feet long on Illinois side of Moline Chain, between the middle and lower end, where dangerous patches existed, was inclosed by ranges and the drill boat commenced work at the southeast corner. It was thought best to first thoroughly improve one-half the width of the channel as laid out, so that boats could run through there with safety while the remaining half was receiving like treatment. The material was found to be very hard, and this, coupled with the swiftness of the current, rendered it difficult to make good headway. Having finished what was staked out at Moline Chain, the drill boat, on September 10, returned to Cabin Chain, reblasted such high points as were discovered while dredging and swept over the worked area to establish the fact that the material above grade was all removed.

This was completed on September 25 and then a large solid rock patch at lower end of Duck Creek Chain was attacked. This patch extended from the line of the Iowa side of the cut well out toward the center of the channel, averaging from 1 foot to 2.5 feet above grade, and was reported by river men as being a great detriment to navigation. The drill boat remained at Duck Creek until October 9, after which date she was set to blast the long shoulder with high patch lying below Buoy 13½, on south side of channel, near head of Winnebago Chain. The removal of this obstruction was greatly desired by raftsmen. A compliance with their request seemed especially proper after the building of Winnebago Dam (No. 7, sheet 47), which forced a very strong cross current over to the head of the chain. As the material was not as hard as usual, operations in blasting were nearly completed at close of season. Drilling during the season was carried to a depth of 2 feet below grade, experience having shown this method to be preferable to shallow drilling, inasmuch as much of the time spent in reblasting could be thus avoided.

The dredge *Ajax* arrived July 14 and was immediately employed removing the broken rock, bowlders, etc., at Cabin Chain. As the débris was widely scattered over the greater portion of this chain considerable time was spent in moving, but the dredge was made to work carefully over the entire shoal areas in order to secure the desired result. Some high points were discovered, which were again blasted and afterwards removed. On September 25 the dredge moved a very large and dangerous rock out of Winnebago Chain into deep water. Duck Creek Chain next received attention from the dredge. Here were found many large rocks scattered over the bottom, especially between the head and a point about the middle of the chain. Owing to shallow water, the dredge could be utilized only at the latter place, just below a solid high reef extending across the channel; but the output was satisfactory, as several barge loads of large and dangerous bowlders were obtained there. The blasted rock at the foot of the chain was next carefully taken up, and the dredge was, October 19, transferred to Moline Chain. Here all the material met with, comprising, in addition to this season's blasting, a very large quantity of loose rock and bowlders within the limits of the area traversed by the drill boat was gathered

up, leaving the entire bottom well down to grade. All the rock handled by the dredge during the season was put in the piers and dams except that at Moline Chain, which was deposited on the old dike running downstream from foot of Benhams Island. The dredge was put into winter quarters November 17.

Removing bowlders.—The very low stage of water affording an excellent opportunity, it was determined to remove bowlders and loose rock from the cut at Duck Creek Chain. For this purpose a barge 80 feet by 16 feet, with 2 capstans, was, on September 30, fitted with two large substantial tripods, one at the side the other at the end, so placed and secured as to bring the apex of each directly over the edge of the barge. This boat was also provided with various-sized anchors, for the purpose of securely mooring and swinging her back and forth across the channel. Having secured blocks and tackle, grappling tongs, etc., a crew was obtained, part of which was employed in the water to search for and fasten the appliances to the bowlders, which were then hoisted on a tender. In this manner the upper half of the chain, including the center patches, was cleared of loose obstructions, many of which, by their deeply worn surfaces, plainly showed contact with boats. Unusually large bowlders were broken up by blasting, and the fragments removed. The water becoming very cold, this work was suspended October 20.

Guide-piers—The procuring of material for the two guide-piers, numbered 4 and 9, was begun July 22, the former being located on south side of channel midway between Piers 3 and 5, the latter on Illinois side of channel near foot of St. Louis Chain. On August 6, a force of masons was set at work, and they were continuously engaged until the completion of the piers September 10. These piers were built like those of 1889, the slope stone, however, being of larger size and better quality. The foundations are 55 feet by 90 feet. The walls are 24 inches thick at upstream end and from 16 to 20 inches thick at lower end, and were commenced well down below the water surface, which was then nearly down to low water of 1864. The core of the piers is of riprap. The dimensions of the base of each pier are 70 feet by 35 feet; of the top, 30 feet by 2 feet; and the piers are built to an elevation of 13 feet above low water.

Dams.—Slight repairs were made to Dam 8, closing Campbells Chute. The construction of new dams was begun July 10. The first built was Dam 7, closing the chute at Winnebago Island. Progress on this dam was slow while the piers were being built, as most of the material that could be obtained was used in the piers. It was found necessary to build a wing dam (6½, sheet 47) from the opposite, or Iowa, shore, in order to check the cross current caused by Dam 7, at head of Winnebago Chain. The water being very shoal on the line of Dam 6½, it was very difficult to put the material in place. Finally, Wing Dam 3 was built from the Iowa shore at the head of Campbells Chain, in the direction of Pier 12. The object of this was to assist in counteracting the cross current, increasing the depth of water, and keeping the upper end of the chain free from sand. Cold weather compelled a suspension of work on this dam November 21, before the outer end could be extended the required distance. These dams are built 9 feet wide on top, and to an elevation of 3 feet above low water. The effect of the dams so far built is to back the water well up to Sycamore Chain, to raise the surface 1.1 feet at Hampton, and 1.5 feet at the head of Campbells Chain and Winnebago Chain.

A close watch was kept on the falling river, and low-water elevations were taken at the proper time over the entire length of the rapids. A comparison made between them and those of 1864 shows that the river, when at its lowest point in 1891, October 2, was at a stage of 0.000 foot at Rock Island, and—0.107 foot at Leclaire, as referred to 1864.

* * * * * * *

Details of operations.

Launch *Louise:*	
Hours working	1,353
Miles run	4,349
Launch *Stella:*	
Hours working	1,276
Miles run	4,201
Drill-boat:	
Hours working	1,419
Hours lost owing to rafts	82
Hours lost owing to accidents	52
Hours lost owing to storms	111
Number of holes drilled	2,917
Number of holes blasted	2,651
Lineal feet of holes drilled	8,972
Range poles set in rock	277
Number of solid cubic yards of rock blasted	3,840
Number of pounds of dynamite used	5,517

Dredge *Ajax:*

Hours working	933
Hours lost owing to rafts	53
Hours lost owing to accidents	114
Hours lost owing to storms	30
Number of solid cubic yards of rock dredged and removed	3,390

* * * * * * *

Cost of rock excavation, including charge for use and deterioration of plant.

Locality.	Rock excavated (solid cubic yards).	Total cost.	Average cost per solid cubic yard.
Cabin Chain, removed	987		
Duck Creek Chain, removed	592		
Moline Chain, removed	1,125		
Total	2,704	$15,556.41	$5.76
Winnebago Chain, blasted only	1,136	3,221.50	2.84
Total	3,840	18,787.91	

Cost of Piers 4 and 9, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Average cost per cubic yard.
Slope-wall stone	462.0	$2,148.69	$4.65
Riprap stone	2,210.6	2,342.88	1.06
Total	2,672.6	4,491.57	
Cost of one pier			$2,245.74

Cost of dams, including charge for use and deterioration of plant.

Designation.	Length.	Rock.	Brush.
Sheet 47:	*Feet.*	*Cu. yds.*	*Cu. yds.*
Dam 3, wing	1,150	6,695.9	
Dam 6½ wing	830	2,868.0	
Dam 7, closing	980	5,082.9	256.0
Total	2,960	14,646.8	256.0

Cost of dams	$15,853.13
Cubic yards of material put in	14,902.8
Average cost per cubic yard in place	$1.06

Financial statement for improvement of Rock Island Rapids for season of 1891.

Amount expended in the field during the calendar year 1891 (from distribution sheets)	$34,706.90
Add quota of general superintendence and office expenses	1,530.42
Add for use and deterioration of plant	3,766.67
Total	40,003.99

Distributed as follows:

1. Rock excavated and removed	$15,566.41
2. Rock broken up, but not removed	3,221.50
3. Piers (4 and 9)	4,491.57
4. Repairs to old piers	410.99
5. Dams (3, 6½, 7)	15,853.13
6. Bowlders removed (107 cubic yards)	460.39
	40,003.99

To illustrate the effect on the water surface and the increased depth thereby attained, I present two tables—the one showing the influence of Dam No. 8, built in 1889; the other showing the combined influence of Dam No. 8 and of Dams Nos. 3, 6½, and 7, built in 1891, and also that of the Rock Island Arsenal water-power dam. A desired increase of slope and current at Campbells Chain was also secured, assisting in the removal of sand deposits, which had hitherto been a detriment to navigation. A sheet, containing map and profiles of water surface of a portion of the rapids, is also presented, for the purpose above indicated. It is believed that, by a judicious use of wing dams, the water surface can be sufficiently raised at Duck Creek Chain to obtain the grade depth of 4 feet at low water, and that the expense of such work will be very much less than that of required amount of rock excavation.

SUMMARY.*

Total amount of material put in during season of 1891 by days' labor and contract .... cubic yards..	307,332.8
Total cost of above, including charges for general superintendence, office expenses, and use and deterioration of plant	$232,460.39
Average cost per cubic yard in place, 75.6 cents.	

BUOYS ON ROCK ISLAND RAPIDS.

The buoys, having been repaired and repainted, were replaced in position April 21 to 24, 1891, by steam launch *Louise*. There were 29 buoys, all of which were secured to the rock bottom by bolts and chains. All the range stakes were carefully examined, repaired, and painted. During the season several of the buoys were carried away by rafts. On November 16 the ranges were adjusted and the buoys were taken up and stored for the winter. The cost of buoyage for the season of 1891 was $397.83.

SURVEYS AND GAUGES.

Examinations were made at different times and at various localities along the river, with a view to future work or for ascertaining the results of work already accomplished. The maps of these examinations will be plotted and used in preparing projects for further improvements.

Numerous observations were also made for determining a low-water datum.

Gauges were kept at Hastings, Redwing, Winona, and Prairie du Chien during the year. Gauge records were also obtained from the Signal Service and bridge-keepers at St. Paul, Rock Island, Keokuk, Burlington, Quincy, Hannibal, and Louisiana. These records are now being plotted.

Amount expended on surveys and gauges during the calendar year was $1,767.23.

PURCHASE, CONSTRUCTION, REPAIR, AND CARE OF PLANT.

During the year, under projects approved January 6 and February 28, 1891, considerable additions and repairs to plant were made. Twenty-nine barges, 100 feet long, 20 feet wide, and 4 feet hold, were purchased at $770 each; a quarter-boat (No. 118) was built by Government employés at the Des Moines Rapids Canal, and repairs were made, principally at the canal, to towboats *Fury*, *Vixen*, and *Alert*, steam launches *Louise*, *Elsie*, *Stella*, *Ada*, and *Emily*, dredges *Phœnix* and *Ajax*, drill-boats 103 and 34, and also to many of the barges and other pieces of plant belonging to this improvement. When not in use the plant was cared for by watchmen at Ninninger, Fountain City, Rock Island, and Des Moines Rapids Canal.

The cost of above-mentioned work was $31,014.39.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

* Improvement of Rock Island Rapids not included in statement.

Water surfaces on Rock Island Rapids showing the effect of Dam No. 8, built during the year 1889.

At Bench-mark.	Inter-mediate dis-tances.	Distances from Bench-mark 5.	Water surfaces. Prevail-ing stage* added to low-water 1864 ele-vation.	Water surfaces. Taken Novem-ber 15, 1889, elevation.	Differ-ences.	Location of benchmarks.
No.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
5.........	....	....	40.271	40.271	....	Above Sycamore Chain.
6.........	1,700	1,700	39.993	40.065	+0.072	At head of Sycamore Chain.
7.........	2,000	3,700	38.334	38.513	+0.179	About 800 feet above foot of Sycamore Chain.
8.........	3,100	6,800	36.903	37.131	+0.228	At head of Crab Island Chain.
9.........	2,650	9,450	36.498	36.881	+0.383	At head of St. Louis Chain.
10.........	3,000	12,450	35.939	36.548	+0.609	About 800 feet below head of Cabin Chain.
11.........	6,400	18,850	35.022	36.132	+1.110	At Hampton, Ill.
XIII½....	3,300	22,150	34.607	36.132	+1.525	About 600 feet above head of Campbells Chain.
12.........	2,800	24,950	34.047	35.034	+0.987	At foot of Campbells Chain.
13.........	1,300	26,250	33.747	34.637	+0.890	Opposite pool below Campbells Chain.
14.........	4,650	30,900	33.073	33.828	+0.756	At head of Winnebago Island.
15.........	4,900	35,800	32.500	32.665	+0.165	Abreast of the pool below Winnebago Island.

*A stage of 0.235 prevailed for several days before and after November 15, 1889, at Suters low-water mark, while at Rock Island Bridge the water fluctuated between 0.75 and 0.95 feet.

Water surfaces on the Rock Island Rapids showing the effect of Dams No. 3, 6½, 7, and 8, built during the years 1889 and 1891, and of Rock Island Arsenal Water Power Dam.

At Bench-mark.	Inter-mediate dis-tances.	Distances from bench-mark 0.	Elevation. Low water of 1864.	Elevation. Low water of 1891.	Differ-ences.	Location of benchmarks.
No.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
0.........	....	....	42.313	42.206	—0.107	At McCaffreys warehouse, Leclaire, Iowa.
1.........	850	850	42.288	42.118	—0.170	Below steamboat warehouse, Leclaire, Iowa.
2.........	2,350	3,200	41.886	41.676	—0.210	1,050 feet below head of Upper Chain.
3.........	1,900	5,100	41.329	41.204	—0.125	Near foot of Upper Chain.
4.........	1,600	6,700	40.373	40.305	—0.068	Opposite Long Pool below Upper Chain.
5.........	1,800	8,500	40.036	39.962	—0.074	Above Sycamore Chain.
6.........	1,700	10,200	39.758	39.769	+0.011	At head of Sycamore Chain.
7.........	2,000	12,200	38.099	38.112	+0.013	About 800 feet above foot Sycamore Chain.
8.........	3,100	15,300	36.668	36.761	+0.093	At head of Crab Island Chain.
9.........	2,650	17,950	36.263	36.608	+0.345	At head of St. Louis Chain.
10.........	3,000	20,950	35.704	36.274	+0.570	About 800 feet below head of Cabin Chain.
11.........	6,400	27,350	34.787	35.923	+1.136	At Hampton, Ill.
XIII½ ...	3,300	30,650	34.372	35.923	+1.551	About 600 feet above head of Campbells Chain.
12.........	2,800	33,450	33.812	35.113	+1.301	At foot of Campbells Chain.
13.........	1,300	34,750	33.512	34.692	+1.180	Opposite pool below Campbells Chain.
14.........	4,650	39,400	32.838	34.230	+1.392	At head of Winnebago Island.
15.........	4,900	44,300	32.265	32.665	+0.400	Abreast of pool below Winnebago Island.
16.........	2,300	46,600	32.040	32.437	+0.397	Just below Masons Break.
17.........	2,200	48,800	31.613	32.144	+0.531	Opposite head of Duck Creek Chain.
19.........	1,350	50,150	31.322	31.662	+0.340	Below middle of Duck Creek Chain.
18.........	900	51,050	31.007	31.152	+0.145	Opposite foot of Duck Creek Chain.
20.........	2,700	53,750	30.590	30.794	+0.204	Abreast of long pool below Duck Creek Chain.
21.........	3,750	57,500	30.090	30.403	+0.313	Above Moline Wing Dam.
22.........	4,200	61,700	28.926	29.238	+0.312	Opposite head of Moline Chain.
23.........	1,500	63,200	27.882	28.182	+0.300	Below middle of Moline Chain.
24.........	1,500	64,700	26.1[illegible]9	26.447	+0.298	Opposite foot of Moline Chain.
25.........	3,700	68,400	24.6[illegible]	2[illegible].931	+0.281	Above Stubbs Eddy.
26.........	5,000	73,400	23.110	2[illegible].[illegible]3	+0.173	Abreast of Lower Chain.
Bridge...	4,800	78,200	21.527	21.527	+0.000	On Rock Island Bridge.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, February 3, 1892.

MAJOR: I have the honor to present the following report of operations for work done under my direction during the calendar year ending December 31, 1891:

KEITHSBURG TO MONTROSE.

The project for this work, calling for construction of brush and rock dams and shore protections, was approved February 28, 1891. The sum of $60,000 was allotted for the purpose. Operations were begun July 20, 1891, and carried on until November 17, 1891, when the fleet was taken into winter quarters in the Des Moines Rapids Canal.

Work was performed by hired labor and use of Government plant, the material being purchased in open market. The prices paid for material on United States barges ranged from 55 to 65 cents per cubic yard for rock and 20 to 25 cents per cubic yard for brush. The extraordinarily low-water season of 1891 extended during the whole time of working. The stage was, from July 1 to December 30, 1891, never above 2.1 feet, and from August 29 to October 15, 1891, it constantly hovered about the zero mark. Such a continued low-water stage is unprecedented, and the fact that many boats and rafts continued to ply the river is the best evidence of the good results accomplished by the works of improvement. Twenty-four million feet B. M. of lumber and 5,000,000 feet of logs reached and passed the Des Moines Rapids Canal during the month of September. In prosecuting the work at low water the dams had often to be built on dry sand bars, and a great saving was effected by the use of a broad-tired (4.5 inches) wagon. The cost of work was much increased by the low stage of water, by the great length of the tow, and by the sinking of towboat *Vixen*, which deprived the work of her services for about a month.

Superintendent S. Edwards was in charge of operations in the field. He was assisted in vicinity of Montrose by Overseer J. R. Carpenter.

I submit extracts from Mr. Edwards's report, which give statements of expenditures and other details:

"*Vicinity of Montrose.*—The work at this point consisted in building Dams 7 and 8 (sheet 62) and in protecting the caving bank above Montrose. The crossing from Devil Island (395) to the Illinois shore, as shown in my survey of July 1, 1891, was not only very crooked, but for the greater distance narrow and shallow, making it especially difficult for rafts. The building of the above dams made a straight crossing, and the scouring soon produced good water.

"The bank above Montrose, since survey of 1888, had cut away 22 feet, and was no doubt the principal cause of filling up Montrose Harbor. Only a part of the caving bank was protected, owing to the close of navigation. The launch *Lucia*, in charge of Overseer J. R. Carpenter, worked at this locality from August 3 to 8, 1891, and from October 1 to close of season.

"*Vicinity of Keithsburg.*—The river below Keithsburg has been troublesome for many years, but perhaps never so much so as during the first three weeks of August, when it was almost impossible for boats to pass without being aground for hours or even days.

"The work here consisted in building Dam 16 (sheet 55), length 2,150 feet, repairing breaks in Dams 15 and 18 (sheet 55), and in extending shore protection on Huron Island (358) 773 feet downstream. The difficulties connected with the work were numerous. The impossibility of getting rock near Keithsburg necessitated a long tow, and the low stage of water made towing very slow and large loads impossible. Arriving with materials at works, the same, especially rock, had to be reloaded on other barges, and from 20 to 30 yards at a time hauled by hand to building barge. Six hundred feet of the dam was built on dry bar, partly by wheeling, partly hauling with team and partly by using pile-driver engine to move wagon loads of material to place.

"Much time was lost by the *Vixen* in helping other boats over this and adjacent bad places. Twenty-four hours' steady work in one case, and perhaps one-fourth of all her time was put in at such work, this of course interfering greatly with her regular employment.

"August 26 the work here was brought to a sudden stop by the *Vixen* sinking at Keithsburg, after striking a submerged pile directly in the channel 800 to 900 feet below the bridge. The boat was raised and taken to the dry dock at the Des Moines Rapids Canal for repairs.

"After the *Vixen* left the dock, September 28, she was employed at Burlington till a rise enabled us to again go to Keithsburg.

"Dam 16 is not completed, but is doing good work, and was left in a safe condition. The channel has straightened out and the scouring produced a good depth.

"The work here went on from August 4 to September 2 and from October 30 to November 7, inclusive, the last part being the building of 773 feet of shore protection on Huron Island. This bank, which was very high, was cutting fast, due in part to the building of Dam 16.

"*Vicinity of Burlington.*—September 3, 1891, the launch *Lucia* brought the fleet from Keithsburg to Burlington, and a force was put at work improving crossing below Otter Island. This crossing was so shallow that only the lightest boats could get over, and they with difficulty, the river, when work was commenced here, having reached the lowest point on record and going below low water of 1864; and, for medium or heavy-draft boats, navigation was shut off.

"Owing to the accident to the *Vixen* the *Lucia* had to do the towing up to September 28, and was run with a double crew. Work was pushed as fast as possible with so small a towboat; but by September 12, notwithstanding the continued falling of the river, 0.5 foot more water was found than on September 3. September 19 barges drawing 3 feet were taken over the crossing. Scouring continued and boats laid up were again brought out and found no difficulties the remainder of the season. From September 28 to October 30 the *Vixen* did the towing.

"The work consisted in building a temporary dam 950 feet long from the Illinois side of the channel; in completing Dam 4 (sheet 58), commenced in 1889, but not completed at the time, owing to the lateness of the season; in building Dam 12 (sheet 58) 945 feet out from foot of Otter Island; in building Dam 9 (sheet 58), length 916 feet, of which 464 feet were built on dry bar. Dams 5, 6, and 10 (sheet 58) were repaired and sand bar between Dams 9 and 10 (sheet 58) was protected by building 609 feet of shore protection.

"*Vicinity of Dallas.*—Operations were carried on at this point from November 10 to 17, when laboring force was discharged and fleet was towed into winter quarters. The channel at foot of Burlington Island was, during the latter part of the season, in a very crooked condition, necessitating a sharp curve to make the crossing. Rafts would frequently get aground, especially if running without a bow boat. This was due to the water drawing into the swift chute between Crow Island (383) and Turkey Island, forming a bar which threatened to entirely shut off the regular channel. Dam 3 (sheet 59), length 230 feet, was built, throwing the water back into the main channel again. This dam, owing to the sudden cold weather, was not ballasted sufficiently, but is in a safe condition. Shore protection of Island 383 was extended up river 540 feet, as here the bank, being high and mostly sand, was cutting fast. The old protection on Islands 383 and 386 received slight repairs.

"*Removing wreck.*—May 25 ice-barge *McCormick*, 160 feet by 25 feet, was sunk in the channel on the Des Moines Rapids, at a point about one-fourth mile above the guard lock of the canal. On June 3 and 4 towboat *Vixen* and dredge *Ajax* were employed and successfully removed the wreck. The cost of above work was $95.50.

"*Removing bowlders near Island 396.*—Towboat *Vixen* and dredge *Ajax* were employed on above work from June 27 to July 9, when the work was discontinued, the dredge being needed at Rock Island Rapids. The patch, which was 150 feet long by 90 feet wide, was situated in about the middle of the proposed new channel, and contained bowlders from 2 feet to 3.5 feet above grade. Nine cuts were made, ranging from 65 feet to 200 feet in length. There were removed 865 cubic yards of bowlders, at a cost of $587.67.

"September 26 to October 1 launch *Lucia* was employed in searching for obstructions at Drew Prairie, Pontoosuc, and Devil Island. A large rock at the latter place was broken into small pieces. The cost of this work was $86.39.

"October 17 to 26 the *J. G. Parke* and dredge *Phœnix* completed the removal of the bowlder patch at Island 396.

"*In general.*—The season throughout was unfavorable to rapid or cheap work. The stage of water, which went below 1864, prevented us most of the time from towing good loads, and necessitated slow and careful navigation. The water at the dams was shallow, the barges had to be reloaded at the works, and small loads pulled in by hand, and much material had to be carried and wheeled to place. At Keithsburg material was wheeled 600 feet in one case. After the purchase of a broad-tired wagon work of this kind went faster; and for building dams on dry bars this is decidedly a success. The sinking of towboat *Vixen* put the work much behind, she being out of service over one month. This forced the launch *Lucia* into work too heavy for her; and, though run day and night, she could not keep up with the demand for material, for which reason I had to employ a very small force.

"Early in October the refusal of all the brush cutters to continue furnishing brush at the original price agreed on, 20 cents per cubic yard, made it necessary to use a greater quantity of rock than was desirable, also increasing the cost of the work.

"It became necessary, in order to get brush at all, to advance the price to 25 cents per cubic yard, and in the meantime the works suffered until the new men got well started

"A great number of logs and snags, found by us or reported to me, were removed as soon as time could be found.

"The temporary dam built above Burlington was, owing to the lateness of the season and the absence of a dredge, not removed. This should be done next spring as soon as possible. A couple of wing dams should be built below the present ones on the Iowa side, to prevent the sand forced through by the other dams from lodging in the channel, which, though deep, showed much filling by the time we left."

List of works constructed and repaired and of materials used, during the season of 1891, between Keithsburg and Montrose.

Designation.	Dimensions.		Material.	
	Length.	Height above low water of 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cubic yards.*	*Cubic yards.*
Sheet 55:				
Dam 16	2,150	2.5	1,877.29	6,482.00
Dam 15, repaired				225.00
Dam 18, repaired				75.00
Revetment Island 358	773	10	1,093.64	567.00
Sheet 58:				
Dam 4	830	3	5,873.64	2,022.00
Dam 9	916		2,145.56	3,403.00
Dam 12	945	4	2,136.68	1,822.00
Dam (temporary)	950	1	129.33	1,624.00
Dam 5, repaired			40.00	
Dam 6, repaired			70.18	
Dam 10, repaired			106.94	
Revetment on sand bar	609	2.5	223.79	400.00
Sheet 59:				
Dam 3	230	4	221.66	1,244.00
Sheet 60:				
Revetment Island 383	540	9	755.72	1,127.00
Revetment Island 383, repaired			100.15	
Revetment Island 386, repaired			81.11	
Sheet 62:				
Dam 7	976	4.5	3,287.02	3,712.00
Dam 8	1,150	3	3,629.10	3,716.00
Revetment above Montrose	1,000	5.5	1,412.72	672.00
Total			23,184.53	27,091.00

Financial statement for works of improvement between Keithsburg and Montrose during season of 1891.

Amount expended in the field during the calendar year 1891 (from distribution sheets)		$38,926.55
Add cost of material on hand January 1, 1891		761.00
		39,687.55
Deduct cost of material on hand at close of season	$3,800.98	
Deduct cost of removing bowlders	674.06	
Deduct cost of removing wrecks	95.50	
		4,570.54
Net cost of field work *		35,117.01
Add quota of general superintendence and office expenses		1,716.74
Add for use and deterioration of plant		3,368.97
Total		40,202.72
Material put in works:		
Rock	cubic yards..	23,184.53
Brush	do....	27,091.00
Total	do....	50,275.53

* See footnote on page 1812.

Average cost per cubic yard on barges	$0.392
Average cost per cubic yard for towing and putting in material*	.307
Average cost per cubic yard for general superintendence and office expenses	.034
Average cost per cubic yard for plant	.067
Average cost per cubic yard in place*	.800

HARBOR AT MONTROSE.

The act of September 19, 1890, made a special allotment of $2,000 for removal of bar at Montrose, and a project for dredging in that locality was approved February 27, 1891. The work was performed by United States dredge *Ajax*, assisted by towboat *Viren*, and was commenced June 1 and completed June 26, 1891. The survey of October 11, 1890, showed the landing to be in very bad condition, in consequence of which bad condition of landing packets frequently refused to land. Since completion of dredging operations the harbor has been in excellent shape. The grade adopted was 5 feet below low water of 1864, except near the ferry landing, where, rock being met with, the dredge was unable to go to the full depth. The cost of the work, though reasonable, was somewhat increased by the necessity of removing two sunken flat boats and numerous logs which had collected thereon. The amount of material removed was 11,465 cubic yards.

Financial statement for dredging work at harbor at Montrose, performed by Government plant during season of 1891.

Amount expended in the field during the calendar year 1891	$1,202.03
Add quota of general superintendence and office expenses	76.90
Add for use and deterioration of plant	357.93
Total	1,636.86
Number of cubic yards of material removed	11,465.00
Average cost per cubic yard removed	$0.143

CARE, REPAIR, AND CONSTRUCTION OF PLANT.

During the year a large amount of repair and construction work was done at the Des Moines Rapids Canal dry dock and shops. A large quarter-boat was built and considerable repairs were made to towboats *Fury*, *Viren*, and *Alert*; steam launches *Elsie* and *Emily*, as well as the dump boats, and many of the barges comprising the plant were also repaired. At such times as the plant was not in use watchmen were employed in caring for same.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1892.

MAJOR: I have the honor to present a preliminary report of operations on the various works in my charge during the second half of the fiscal year ending June 30, 1892:

MINNEAPOLIS TO ST. PAUL.

On May 3, 1892, repairs to plant to be used on the work of building dams and shore protections and in removing bowlders from channel limits were begun. These repairs were completed May 24, when, the water being too high for advantageous work,

* If the expense of raising and repairing towboat *Viren*, sunk at Keithsburg during progress of work, be deducted from net cost of the field work, the average cost per cubic yard for towing and putting in material would be $0.269, and the average cost per cubic yard in place would be $0.762.

the fleet was laid up in Boulanger Slough. Under the agreement with Mr. C. H. Appleton dredging with his plant was resumed May 27, 1892. During the remainder of the month and in June the plant was employed in deepening the channel at middle and head of Pike Island and below Fort Snelling Bridge. The dredged material was deposited on the lines of proposed Dams 1 and 2 (sheet C) and in the form of shore protection in the bend of Pike Island. The dredge was employed to June 30, 1892, three hundred and thirty-one hours and fifteen minutes, and removed from the channel 16,965.3 cubic yards of material, consisting of sand, fine gravel, sawdust, and edgings.

ST. PAUL TO PRESCOTT—PRESCOTT TO LAKE PEPIN—MINNEISKA TO LACROSSE—ROCK ISLAND RAPIDS.

No work has been done at these localities on account of high water. Repairs have been made to portions of the plant to be used.

BELLEVUE TO SAVANNA.

From the appropriation of September 19, 1890, an allotment of $25,000 was made for work in this locality. A project calling for construction of rock and brush dams and shore protections was approved January 6, 1891. Contract for the work was let to Patterson Brothers, of Keokuk, Iowa, March 2, 1891, at 90 cents per cubic yard for rock in place and 38 cents per cubic yard for brush in place. The time for completion of contract, which was originally November 15, 1891, has been extended to November 15, 1892.

Operations were begun May 12, 1892, in the construction of Dam 1 (sheet 40), closing chute of Island 257, and suspended May 20, on account of high water. Three hundred and ninety-four and six-tenths cubic yards of rock and 495 cubic yards of brush were put in the work, which will be resumed as soon as the river falls to a suitable stage.

BUOYS ON ROCK ISLAND RAPIDS.

The buoys, having been repaired and repainted, were reset April 5 to 12, 1892, by steam launch *Louise*. There are now 31 buoys in the system, 29 of which were reset. The chains of Nos. 13¼ and 21¼ could not be found; but these will be searched for and the buoys attached later in the season. All the range stakes were carefully examined and repaired.

SURVEYS AND GAUGES.

Gauges have been kept at Hastings, Redwing, Prairie du Chien, and Winona. Examinations of the river were made in the vicinity of Queens Bluff, below Dubuque, and between Sand Prairie and Arnolds. Maps of these examinations have been plotted.

Very respectfully, your obedient servant,

C. W. DURHAM,
Assistant Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1892.

MAJOR: I have the honor to present a preliminary report of operations during the second half of the fiscal year ending June 30, 1892:

KEITHSBURG TO MONTROSE.

On May 2, 1892, launch *Lucia* was put in commission and started out with fleet for work near Pontoosuc, in charge of Mr. S. Edwards, superintendent. The river continued to rise so fast that by the time the fleet reached Dallas City the banks of the river were under water and all work had to be abandoned. The fleet was laid up in Dallas Chute in charge of a watchman, and the *Lucia* returned to Keokuk May 7, 1892.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Maj. A. MACKENZIE,
Corps of Engineers, U. S. A.

APPENDIX Z.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA, OF CHIPPEWA RIVER, WISCONSIN, OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA, OF MINNESOTA RIVER, MINNESOTA, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

REPORT OF MAJOR W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mississippi River above Falls of St. Anthony, Minnesota.
2. Reservoirs at headwaters of Mississippi River.
3. Chippewa River, including Yellow Banks, Wisconsin.
4. St. Croix River, Wisconsin and Minnesota.
5. Minnesota River, Minnesota.
6. Red River of the North, Minnesota and North Dakota.
7. Surveys for reservoirs at the sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers.
8. Gauging Mississippi River at or near St. Paul, Minnesota.

EXAMINATION AND SURVEY.

9. Red River of the North and tributaries above Fergus Falls and Crookston, Minnesota, and Big Stone Lake, Minnesota and South Dakota.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minnesota, July 5, 1892.

GENERAL: I have the honor to transmit herewith reports upon the works for improvement of rivers and harbors in my charge for the fiscal year ending June 30, 1892.

* * * * * * *

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF MISSISSIPPI RIVER ABOVE FALLS OF ST. ANTHONY, MINNESOTA.

The present project, under which work has been carried on since and including 1880, is based upon the project for the improvement of 117 miles of the river, from Conradi Shoals to Grand Rapids, the latter the present head of steamboat navigation. The estimated cost, $54,127.50, is given in the report of February 8, 1875, upon part of the Mississippi routes to the seaboard, plan of improvement to afford 3 to 5 feet depth in the channel by removing snags, bowlders, and bars, and confining the low-water discharge to widths practicable for navigation by means of wing dams where necessary. In 1889 the estimate was increased to $63,000.

This same report (1875) estimated the cost of improvement of the river between the Falls of St. Anthony and St. Cloud at $144,667.50, the improvement of this section to afford 5 feet depth in the channel at low water between the Falls and St. Cloud by removal of sand, gravel, and bowlder bars and the construction of wing dams. The sum of $20,000, appropriated by act of Congress approved August 14, 1876, was expended between these places. Prior to the rendition of the report and estimate of February 8, 1875, Congress had appropriated, by act approved June 23, 1874, the sum of $25,000 for improvement of the river above the Falls of St. Anthony, which was also expended in improving the channel between the Falls and St. Cloud.

Steamboat navigation having discontinued between the Falls and St. Cloud, a distance of 78 miles, the third appropriation made by Congress, that of $15,000, by act of Congress approved June 14, 1880, was applied to the stretch (130½ miles in length) of river between Aitkin and Grand Rapids, as have been all subsequent appropriations for improving the river above Falls of St. Anthony, except the appropriation made by act of Congress approved September 19, 1890, which was applied to the stretch (185.4 miles in length) of river between Grand Rapids and Brainerd (this stretch included within the distance from the Rapids to Conradi Shoals).

Before work of improvement commenced under the present plan, the stream between Grand Rapids and Aitken was so obstructed by snags, bowlders, and leaning trees that at low and even high stages of water navigation was difficult and sometimes almost impossible for steamers drawing more than 3 feet of water.

The amount expended on present project to June 30, 1891, including outstanding liabilities, is $55,439.35. With this sum there had been produced a general depth in the improved channels of 3 feet at low water. A few snags and leaning trees offered some obstruction, but did not seriously interfere with navigation.

Field work during the past fiscal year was performed between July 25 and September 15, 1891, in removing snags and leaning trees between Grand Rapids and Aitkin.

The following is a statement of work performed during the fiscal year ending June 30, 1892:

	Diameter.													
	6-inch.	8-inch.	10-inch.	12-inch.	14-inch.	16-inch.	18-inch.	20-inch.	24-inch.	28-inch.	30-inch.	34-inch.	36-inch.	Total.
Snags removed	....	16	33	29	12	20	17	15	17	9	9	8	6	191
Leaning trees removed	6	75	84	86	18	23	27	8	9	2	6	2	....	346

There being no demand at present for navigation between Brainerd and Minneapolis, no further appropriation is now asked for. The time will come when this should be done. I will say, in conclusion, that this reach may be placed in excellent navigable condition at quite a reasonable expense.

Amount expended during the fiscal year ending June 30, 1892, including outstanding liabilities, $5,738.51.

The balance of funds on hand will be expended in removing snags and leaning trees between Aitkin and Grand Rapids.

The three completed reservoirs at the headwaters of the Mississippi River, above Grand Rapids, may be relied upon henceforth to provide sufficient water and depth for the steamboats on the river at and above Brainerd.

Last season two steamers with barges were engaged in freight and passenger transportation between Aitkin and Grand Rapids. During the winter of 1889-'90 the Duluth and Winnipeg Railway Company constructed a line from Cloquet, a point on the St. Paul and Duluth Railway, to La Prairie. They have since extended their line through and beyond Grand Rapids.

In 1889, my predecessor, Maj. C. J. Allen, reported:

The comparative tables of commercial statistics herewith show that in 1880, the year in which the work of improvement between Aitkin and Grand Rapids commenced, there was but one steamer (with its barges) plying between those points, and that though the amount of freight transported that year by steamer was unusually large, the freight rates were from 75 cents to $1 per hundred pounds, while in 1883, 1884, 1885, and 1886 the rates reduced to 20 to 40 cents per hundred pounds The last-named figures obtained in 1886, at which time there were three steamboats engaged in freighting and carrying passengers between Aitkin and Grand Rapids. The country bordering the river north of Aitkin is becoming more and more settled, and there is no doubt that the improvement of the river already effected by the United States Government has largely contributed to the increase in settlement.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1891, $299,659.32; value of domestic exports for same period, $452,251.

Abstract of appropriations.

By act approved—	
June 23, 1874	$25,000
August 14, 1876	20,000
June 14, 1880	15,000
March 3, 1881	10,000
By act passed August 2, 1882	10,000
By act of August 11, 1888	10,000
By act approved September 19, 1890	18,000
Total	108,000

Money statement.

July 1, 1891, balance unexpended	$7,592.27
June 30, 1892, amount expended during fiscal year	5,749.21
July 1, 1892, balance unexpended	1,843.06
July 1, 1892, outstanding liabilities	20.92
July 1, 1892, balance available	1,822.14

COMMERCIAL STATISTICS.

Comparative statement of steamboat business on the Mississippi River between Aitkin and Grand Rapids, 1880-'90, inclusive.

Year.	Steamboats.	Freight carried.	Passengers carried.	Total tonnage.	Year.	Steamboats.	Freight carried.	Passengers carried.	Total tonnage.
		Pounds.	*Tons.*				*Pounds.*	*Tons.*	
1880*	1	7,847,250	1,000	....	1886	3	3,000,000	3,500	....
1881	1	2,200,000	1,540	....	1887	3	3,710,400	2,884	....
1882	2	3,026,000	1,764	....	1888	3	5,321,443	2,860	2,890
1883	2	2,800,000	1,100	....	1889	2	7,000,000	5,250	3,925
1884	2	16,000,000	1,346	....	1890 †	‡1	3,212,550	1,253	1,606
1885	2	5,000,000	2,400	....	1891 †	‡2	3,000,000	1,000	1,580

*Amount of commerce and navigation when work of improvement began.
†Amount of commerce and navigation 1890 and 1891, approximate.
‡Tonnage of steamboats, 140 and 185 tons, respectively.

Comparative statement of loose logs run on the Mississippi River above the Falls of St. Anthony.

Year.	Loose logs run.	Year.	Loose logs run.
	Feet, B. M.		*Feet, B. M.*
1880	226,000,000	1886	282,600,000
1881	238,000,000	1887	*265,000,000
1882	285,000,000	1888	*265,000,000
1883	420,000,000	1889	288,000,000
1884	367,000,000	1890	325,669,280
1885	317,993,000	1891	425,716,970

*Approximate.

Z 2.

RESERVOIRS AT HEADWATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendices to various Annual Reports of the Chief of Engineers. The résumé of the subject is given in the Report of the Board of Engineers, printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted and further examinations in 1880, the first cost of constructing forty-one reservoir dams in Minnesota and Wisconsin was placed at $1,809,083, exclusive of that of land damages, which could not be given in advance. (See page 1871, Appendix W, to Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winibigoshish, made by act of Congress approved June 14 that year. For the reasons given in the Annual Report for 1886 the work of construction was commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the head waters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi

River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

There are four completed reservoirs, viz:

At Lake Winibigoshish, completed in 1883-'84; capacity, 45,800,000,000 cubic feet.

At Leech Lake, completed in 1884; capacity 30,000,000,000 cubic feet.

At Pokegama Falls, completed in 1884, lift of dam increased in 1889; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity 7,500,000,000 cubic feet.

Rules and regulations to control the use and administration of the reservoirs were formulated and approved by the Secretary of War February 21, 1889, as authorized by the river and harbor act of August 11, 1888. Gaugings of the Mississippi River at St. Paul, to determine the effect of reservoir water, have been made to a limited extent during the past three years; they form the subject of a separate report.

During May and June, 1891, men and materials for constructing the Sandy Lake Dam were assembled.

Amount expended upon this work, including examination at proposed dam sites, hydrological observations, land damages, amounts paid to commissioners in attempted settlement of awards to Indians, and care and maintenance of the works to the close of the fiscal year ending June 30, 1891, $619,850.20.

Operations during the past fiscal year.—At the completed reservoirs.—The operation and care and protection of dams and recording hydrological and meteorological data.

During the months of May and June the reservoirs came under a condition of heavy flood. To meet the unusual requirements extra watchmen and runners were employed and daily communication was kept up with Pokegama Dam, while by means of the runners reports reached me every second day from the reservoirs above. Pokegama Reservoir soon filled to within one foot of the greatest height which it can bear, when it was discovered that the piers which hold the log boom would have to be raised higher before allowing the water to rise. A discharge of 1,000 cubic feet per second was found to be sufficient to hold the water at a stand while the piers were being raised. Soon after the head was allowed to increase one of the gate stems pulled out, indicating a weakness in an unexpected quarter. That is to say, the fastenings of the gate stems, having been designed for a head of 10 feet, could not be relied upon after the accumulation of a head of 12.3 feet. This made it necessary to restrict the head for the present to 12 feet. As soon as possible the gates will be strengthened and some minor alterations made at the log sluice entrance, which will permit a head of 13.5 feet.

At Sandy Lake Reservoir.—The construction of the dam for this reservoir was proceeded with and is now well under way. It will be completed by November. The titles to lands that will be overflowed by the construction of Sandy Lake Dam were acquired by condemnation proceedings. During the month of May a heavy flood came upon Sandy Lake and the Mississippi River. The water rose above the crest of the cofferdam, but foreseeing the danger, I ordered splash boards put on, which gave an additional height of 3 feet. The cofferdam has held all right under these trying conditions. It was expected that the dam would be completed during the season of 1891, but the site was nearly

inaccessible except by way of the river, and the latter was so continually crammed with log drives as to make it impossible to assemble the materials soon enough. Advantage was taken of the roads and the frozen surfaces of lake and marsh during the winter to assemble nearly all of the remaining materials and supplies for completing the work in one season.

The operation of the dam at Sandy Lake involves a peculiar feature. The dam has for its object the storing of water, the release of the same for navigation purposes, and the passing of log drives, which the interposition of an obstruction in the navigable waterway necessitates.

A sketch showing the relative position of the reservoir, the dam, and the Mississippi River is herewith.* From this it will appear that when the discharge from Pokegama Reservoir is sufficient to raise the level of the water in the Mississippi River just below the dam higher than the level of the water in the reservoir, the conditions of head and pressure on the dam will be reversed.

As a matter of fact these conditions will frequently obtain, and this necessitates peculiar constructions to meet them. The ordinary slide valve at the bottom which is used for discharging water will be relieved from back pressure by using the stop planks designed for use in case of repairs. For the log sluice, I have designed a reversible bear-trap gate, which is illustrated in the drawings herewith.† It is composed of two leaves, of uniform size and structure, connected by suspension chains, so that they will fold on the bottom the one upon the other. Each leaf is competent to carry the whole pressure on the gate. The opening between them is closed by a fender or idler, which closes the hydraulic chamber and keeps it free from drift. In order to insure a rapid lowering of the leaves, sufficient iron has been introduced to overcome the flotation of the gate, and sink it. A portion of this iron is disposed so as to stiffen the gate and a portion so as to resist the abrasion of passing logs. To overcome this weight in raising the leaves, sufficient air under pressure is led into a bag lying transversely beneath each leaf. This air it admitted through the hinge rods, which are made hollow for the purpose. It is operated as follows: The gate being folded on the floor, water is let into the closed hydraulic chamber below it from the upper level. The pressure of this water raises the gate and closes the sluice. If there should not be sufficient head to start the gate, air is forced into one or both of the air bags sufficient to raise the crest of the downstream leaf to the water surface. Thereafter the flow alone, or, taken with the increased flotation, will hold the gate closed. To open the gate, connection between the upper level and the hydraulic chamber is closed, and at the same time that between the chamber and the lower level is opened by one movement of the valve, and the gate folds upon the bottom. Its crest can be held at any intermediate point by a proper adjustment of the valve. This for sluicing logs, which can thus pass freely over the crest of the weir. When the head of water changes from one side of the dam to the other, if there is sufficient depth to allow the crest of the hanging leaf to pass clear of the other it will do so through the aid of its air bag. When both are at same level, both leaves are raised by means of the crab, so as to allow the fastenings of the idler to be changed for reversal, and they are then lowered. As soon as the change of head takes place the upstream leaf will fall to a pendent position. In case

*Not submitted.

†Not printed.

there should not be sufficient height of water to allow the leaves to pass, we have the conditions of the old bear trap, and nothing need be done. It may, however, be advisable sometimes to raise the leaves artificially and assist the reversal of the gate thereby.

Table showing cost of subsistence at Sandy Lake Dam, June 1, 1891, to April 30, 1892, inclusive.

Articles.	Total quantity received, July 1, 1891, to May 1, 1892.	Total cost.	Quantity on hand April 30, 1892.	Average cost per pound, gallon, etc.	Value.	Total quantity consumed.	Cost.
Apples, evaporated ....pounds..	375	$51.50	57	$0.138	$7.87	318	$43.63
Allspice, ground ....do..	3	.72	2½	.24	.60	½	.12
Apricots ....do..	325	47.51	67	.157	10.52	315	36.99
Beef:							
Mess ....do..	1,800	67.70	180	.038	6.84	1,620	60.86
Fresh ....do..	4,829	296.39	....	.061	....	4,829	296.39
Canned ....do..	308	29.35	....	.095	....	308	29.35
Bacon ....do..	308	32.85	....	.107	....	308	32.85
Beans:							
Navy ....do..	1,265	40.74	127	.032	4.06	1,138	36.68
Lima ....do..	48	2.10	....	.044	....	48	2.10
String ....do..	312	14.78	....	.047	....	312	14.78
Baking powder ....do..	58¾	24.78	5	.422	2.11	53¾	22.67
Butter ....do..	1,963	375.06	90	.191	17.19	1,772	357.87
Beets ....do..	212	2.90	....	.013	....	212	2.90
Crackers ....do..	356	24.92	120	.07	8.40	236	16.52
Corn:							
Canned ....do..	528	27.45	154	.052	8.00	374	19.45
Green ....ears..	284	2.18	....	.077	....	284	2.18
Starch ....pounds..	46	3.17	13	.069	.90	33	2.27
Cinnamon, ground ....do..	10	2.65	3	.265	.80	7	1.85
Cheese ....do..	292	33.48	15	.114	1.71	277	31.77
Cloves ....do..	5	1.57	2¾	.31	.85	2¼	.72
Coffee, Arbuckle's ....do..	409	103.36	81	.252	20.41	389	82.95
Currents, dried ....do..	15	1.10	10	.073	.73	5	.37
Cranberries ....do..	65	4.66	....	.071	....	65	4.65
Cabbage ....do..	2,645	26.45	....	.01	....	2,645	26.40
Citron ....do..	1	.30	....	.30	....	1	.30
Codfish ....do..	338	24.17	12	.071	.85	326	23.32
Eggs ....dozen..	30	5.70	6	.19	1.14	.24	4.56
Extract:							
Lemon ....quarts..	9	12.80	2	1.422	2.84	7	9.96
Vanilla ....pints..	4	4.30	½	1.075	.53	3½	3.77
Flour: ....pounds..	8,850	212.20	750	.024	18.00	7,800	194.20
Graham ....do..	275	6.60	25	.024	.60	250	6.00
Buckwheat ....do..	50	2.00	....	.04	....	50	2.00
Fish, fresh ....do..	196	13.38	50	.068	3.40	146	9.98
Ginger:							
Ground ....do..	7	1.81	2	.26	.52	5	1.29
Jamaica ....ounces..	34	3.15	2	.093	.20	32	2.95
Ham ....pounds..	1,308½	135.91	50	.104	5.20	1,258½	130.71
Hominy ....do..	42	1.38	25	.033	.82	17	.56
Hops ....do..	2½	.85	½	.34	.17	2	.68
Kerosene oil ....gallons..	244½	26.80	75	.109	8.17	169½	18.63
Lard ....pounds..	739	57.39	75	.077	5.77	654	51.62
Macaroni ....do..	28	3.54	4	.126	.50	24	3.04
Matches ....boxes..	600	5.20	288	.0087	2.40	312	2.80
Mackerel ....pounds..	300	33.75	50	.11¼	5.62	250	28.13
Meal:							
Corn ....do..	260	4.67	35	.018	.63	225	4.04
Oat ....do..	175	6.45	25	.037	.92	150	5.53
Milk, condensed ....cans..	122	20.59	25	.17	4.20	97	16.39
Milk ....quarts..	1,220	61.00	....	.05	....	1,220	61.00
Molasses ....gallons..	45	18.25	15	.405	6.07	30	12.18
Mustard:							
Common ....pounds..	14	4.28	2½	.306	.76	11½	3.52
French ....do..	1	.27	....	.27	....	1	.27
Nutmegs ....do..	3	2.35	½	.783	.39	2½	1.96
Onions ....do..	960	17.00	....	.0176	1.06	900	15.94
Potatoes ....do..	14,783	131.80	420	.019	3.78	14,363	128.02
Prunes ....do..	350	30.70	13	.088	1.14	337	29.56
Pork, mess ....do..	3,000	180.00	700	.06	42.00	2,300	138.00
Peaches, canned ....do..	621	39.44	27	.062	1.67	594	37.77
Peas:							
Canned ....do..	468	25.63	38	.055	2.09	430	23.54
Dried ....do..	75	1.95	14	.026	.36	61	1.59
Pickles ....gallons..	48	16.00	5	.33⅓	1.66	43	14.34

Table showing cost of subsistence at Sandy Lake Dam, etc.—Continued.

Articles.	Total quantity received, July 1, 1891, to May 1, 1892.	Total cost.	Quantity on hand April 30, 1892.	Average cost per pound, gallon, etc.	Value.	Total quantity consumed.	Cost.
Pepper:							
Ground .... pounds..	26¼	$7.08	5¼	$0.27	$1.48	20¾	$5.60
Red .... do..	2	.76	....	.38	....	2	.76
Raisins .... do..	125	14.42	5	.115	.57	120	13.85
Rice .... do..	275	19.04	64	.07	4.48	211	14.56
Salt:							
Table .... do..	245	3.50	40	.014	.56	205	2.94
Common .... barrels..	2	3.85	½	1.925	.96	1½	2.89
Saleratus .... pounds..	24	1.67	2	.07	.14	22	1.53
Sage, ground .... do..	3	.90	2	.30	.60	1	.30
Soap:							
Common .... do..	453	29.63	90	.065	5.85	365	23.78
Castile .... do..	13	1.85	....	.142	....	13	1.85
Sugar:							
Granulated .... do..	3,070	150.31	502	.049	24.60	2,568	125.71
Yellow "C" .... do..	1,160	53.13	140	.046	6.44	1,020	46.69
Sauce, Worcestershire .... quarts..	7½	5.82	....	.776	....	7½	5.82
Sirup .... gallons..	30	10.50	7	.35	2.45	23	8.05
Tea, Japan .... pounds..	221	69.65	17	.315	5.35	204	64.30
Tomatoes, canned .... do..	576	19.00	24	.033	.80	552	18.20
Turnips .... do..	1,752	11.68	210	.061	1.28	1,542	10.40
Tapioca .... do..	6	.30	....	.05	....	6	.30
Vinegar .... gallons..	35	7.24	7	.207	1.45	28	5.79
Yeast cakes .... packages..	39	1.93	10	.049	.49	29	1.44
Freight	....	69.60	....	....	....	....	69.60
Total	....	2,810.84	....	....	271.95	....	2,538.89

Cost of subsistence supplies purchased June 1, 1891, to May 1, 1892	$2,741.24
Freighting	69.60
Total cost, including freighting	2,810.84
Less value of supplies on hand April 30, 1892	271.95
Cost of supplies consumed, June 1, 1891, to May 1, 1892	2,538.89
Number of rations consumed, June 1, 1892, to May 1, 1892	9,315.00
Cost of each ration	0.27¼

Amount expended during fiscal year ending June 30, 1892, including outstanding liabilities, $64,192.03.

The beneficial effects resulting in previous years from the operation of the completed reservoirs have been maintained.

The Board of Engineers, in their report dated May 24, 1887, and printed on pp. 1681–1698, Annual Report of the Chief of Engineers, 1887, express this opinion:

> As far down as the mouth of the first considerable tributary, the St. Croix, it is therefore not unreasonable to suppose that navigation may be benefited nearly in proportion to the effect upon the St. Paul gauge, *i. e.*, from 1 foot to 18 inches at low-water stages.

My predecessor, in his annual reports for the years 1887, 1888, and 1889, has stated:

> From such observations as means admitted of in 1885 and 1886, and stated in my reports of December 18, 1885, and November 5, 1886, both of which are here respectfully referred to, it appeared that when the river stood at 2 feet on the U. S. Signal Service gauge at St. Paul, the effect of every 100 cubic feet per second of water added to the river and steadily maintained was equivalent to increasing the depth one-tenth of a foot. As the river rises the depth effect of each 100 cubic feet of water decreases somewhat. It appears, however, from examinations in 1885 and 1886, that the effect of the liberated water from the four reservoirs was the addition of 1 foot and upwards to the depth at St. Paul, during the dry periods of those years, the additional depth being due to elevation of water surface as well as to additional scour. (See Appendix AA, Annual Report, 1887.)

The benefit of the reservoir volume extended over some 425 [390] miles of river below Grand Rapids, the rapids being 388 [353] miles, by river, above St. Paul. Of the 425 [390] miles 200 [165] are navigated by steamers.

The increase in channel depth at St. Paul due to the release of the stored-up water undoubtedly averaged for the 86 days 1 foot to 1¼ feet. (See Appendix Z, Annual Report, 1888.)

The increase in channel depth at St. Paul due to the reservoir water undoubtedly averaged 1 foot during the low-water season of 1888. (See Appendix B B, Annual Report, 1889.)

The effect of the reservoirs on the navigable depth of water in the channel of the Mississippi River above the Falls of St. Anthony is not as conclusively shown as it could be. A series of hydrological and meteorological observations on the Mississippi and the principal tributaries above St. Paul, extending over a period of several years, would furnish information, not only of great practical value in the operation of the reservoirs, but would also be of scientific value in connection with the loss of river water by evaporation and filtration, and in the progression (and even dispersion) of a flood wave. A commencement in this direction has been made by the provision for gaugings at or near St. Paul, but the money available for the purpose is inadequate for thorough work, and is only applicable near St. Paul. It is estimated that the sum of $15,000 per annum can be profitably expended in hydrological and meteorological investigations during a period of 4 years.

The sum of $31,000 can be profitably expended during the fiscal year ending June 30, 1894, as follows:

Operation and maintenance of the five completed reservoirs	$16,000
Hydrological and meteorological investigations	15,000
	31,000

For commerce benefited by the reservoirs, reference must be made to the commercial statistics of the Mississippi River.

For valuable assistance in work upon and management of the reservoirs, I am greatly indebted to Mr. Archibald Johnson, assistant engineer.

Abstract of appropriations.

By act approved June 14, 1880	$75,000
By act approved March 3, 1881	150,000
By act passed August 2, 1882	300,000
By act approved July 5, 1884	60,000
By act approved August 5, 1886	37,500
By act of August 11, 1888	12,000
By act approved September 19, 1890	80,000
By act approved July 13, 1892	60,000
Total	774,500

Allotment per letter from Office Chief of Engineers—	
November 9, 1881	$1,572.15
January 20, 1882	176.00
January 18, 1888	643.85
May 11, 1888	8.60
Expenses of commissioners in attempted settlement of awards to Indians	333.73
Allotted and expended by officer in charge for meteorological observations, borings, examinations, etc., at proposed dam sites, letter from Office of Chief of Engineers, May 27, 1881	7,500.00
Expended by officer in charge in connection with the building and operating of five reservoir dams to June 30, 1892, including outstanding liabilities	673,807.90
Total allotted and expended to June 30, 1892, including outstanding liabilities	684,042.23

Estimated cost of the system (omitting that of land, etc., damages)	1,809,083.50
Amounts appropriated	774,500.00
Remaining to be appropriated	1,034,583.50

Money statement.

July 1, 1891, balance unexpended	*$95,690.28
June 30, 1892, amount expended during fiscal year	55,908.67
July 1, 1892, balance unexpended	39,781.61
July 1, 1892, outstanding liabilities	9,323.84
July 1, 1892, balance available	30,457.77
Amount appropriated by act approved July 13, 1892	60,000.00
Amount available for fiscal year ending June 30, 1893	90,457.77
Amount (estimated) required for completion of existing project	1,034,683.50
Amountthat can be profitably expended in fiscal year ending June 30, 1894	31,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

A CONDENSED HISTORY OF THE RESERVOIRS, PROPOSED AND BUILT, AT THE HEAD WATERS OF THE MISSISSIPPI RIVER AND TRIBUTARIES, WITH A BRIEF RÉSUMÉ OF THE RESULTS UP TO THE CLOSE OF THE SEASON OF 1887.

Though the project does not appear to have been presented as a new one, the first recorded reference as to the possibility or desirability of the formation of a series of reservoirs at the head waters of the Mississippi River is found in the report of Gen. Warren to the Chief of Engineers, U. S. A., dated August 21, 1868, in which he introduces the matter as one that had been discussed and urged, and in which he recommends an appropriation of $10,000 for a survey of the Mississippi River above the Falls of St. Anthony, and an examination of the lake system at the head waters of the river, with the view of settling the question as to the possibility of flood water being retained at that point for the benefit of navigation on the lower river at low stages.

It appears that at the time of Gen. Warren's first survey of the Mississippi River in 1866, the Minneapolis Water Power Company were trying to protect the Falls of St. Anthony by the construction of an apron, but the high water of 1867 nearly destroyed the work, and a large section of the limestone ledge was subsequently carried away.

The work was repaired in 1869, but high water again this time, aided by the tunnel built for the extension of the water-power facilities, seriously injured the works and threatened the entire destruction of the falls, and it became necessary to do something, if possible, to reduce the flood discharges, both on account of the direct damage inflicted by the floods and the prevention of the continuance of the protective works to completion.

In this emergency the question of the retention of the water in reservoirs was naturally urged, and Gen. Warren being still in charge of the survey of the Mississippi River an appeal was made to him for aid in preserving the falls.

Gen. Warren favored an examination of the lakes, as previously mentioned, and as, in this case, the retention of water would serve the purpose of both parties, he expressed his willingness to give all the aid he could. There was, however, no money available to make the preliminary examination that was necessary before the matter could be presented to Congress in the proper shape.

At this point in the proceedings the Water Power Company volunteered to furnish the necessary funds, and the services of a Mr. Cook, a Minneapolis engineer, were secured for the work.

Mr. Cook's examination was made late in the fall of 1869, was simply of the nature of a reconnoissance and was all that could be expected under the circumstances. He reported that one dam at Pokegama Falls with a rise of 16 feet would flood Leach Lake and Lake Winnibigoshish 2 feet each, and that the river between the lakes and Pokegama Falls would be raised, on an average, 4 feet, forming a flooded area of 523 square miles, capable of retaining about 39,000,000,000 cubic feet of water.

Mr. Cook also examined Pine River and the lakes in that vicinity, and Mille Lacs, a very large sheet of water in Mille Lacs County; in the former he reported that 5,000,000,000 cubic feet of water could be retained, in the latter, about 10,000,000,000 in all, Pokegama, Mille Lacs, and Pine River, about 59,000,000,000 cubic feet, suf-

* In annual report, 1891, amount unexpended July 1, 1891, was stated as $80,027.11. In February, 1892, the amount of $15,663.17 was transferred back to the appropriation from amounts set aside in 1882 for payments of awards to Indians.

ficient to furnish 6,000 cubic feet per second for 104 days, enough, he estimated, to add 2 feet to the ordinary low-water stage of the river below St. Anthonys Falls.

The estimated cost of the three dams was	$114,340
Pokegama Dam, 16-foot rise, built of stone	52,540
Pine River Dam, 16-foot rise, built of timber	31,808
Mille Lacs, built of timber	30,000

It may be mentioned here that a 16-foot dam at Pokegama would not have accomplished what was claimed, as it was determined by the survey of 1874 that Leech Lake was 26.9 feet and Winibigoshish 24.1 feet above the water surface at Pokegama, and from a later survey it was estimated that a 24-foot dam, with the necessary dikes, although it would not back the water up into either lake to an appreciable extent, would cost about $690,000, and a 30-foot dam, capable of raising Leech Lake 3.1 feet, and Winibigoshish 6 feet, would cost somewhere in the vicinity of $1,161,798, leaving out entirely the cost of damages to overflowed lands.

The reservoirs formed by this latter dam, it is estimated, would have been capable of retaining 71,000,000,000 cubic feet of water, probably a very large underestimate. As the general level of the country in the vicinity of Pokegama is considerably less than 30 feet, there is no knowing where the water would have gone.

By the way, it is not intended that this should be understood as a criticism on Mr. Cook's report. The fact is that at one time the construction of a dam at Pokegama to retain all the water was very strongly urged and these were the reasons why it was not done.

The facts, as set forth by Mr. Cook, were so favorable that Gen. Warren, in his report of 1869, after expatiating on the possible benefits to be derived from the retention of so large a quantity of water, both to the work at the Falls and to low-water navigation, recommended that an appropriation be made for a thorough survey. Five years later, in 1874, the General Government having in the mean time undertaken the preservation of the Falls for the benefit of navigation on the river above them, an appropriation was made and a survey ordered.

Col. F. W. Farquhar was in charge of the work of this district at that time, and the survey was made under his direction. The area examined was very extensive, taking in the main portion of the watershed of the Mississippi River from Aitkin to Cass Lake, Pine River, Gull River, and Mille Lacs.

The work at the three latter consisted mainly in examinations to determine if suitable dam sites were obtainable, as the existing Government surveys supplied sufficient data to determine the extent of the watersheds and the area of the lakes suitable for reservoirs.

On the Mississippi River the area that required actual surveys was very large, including Leech Lake, Cass Lake, Lake Winibigoshish, Mud Lake, Pokegama Lake, and some 300 miles of river. Some portions had been covered by the Government surveys, but there were large areas in which even this aid to the work was lacking.

The examination was commenced early in July and completed about the 1st of November, short four months. During that time the areas of the lakes and rivers and probable flowage lines were determined, suitable sites for dams selected and examined, and lines of levels were run connecting the entire system, giving the elevation of the lakes and the slopes of the rivers. Numerous gaugings were also made to determine, as far as possible, the probable discharge of the streams. The force employed consisted of 7 engineers and about 50 men, divided into three parties.

The result of this survey was a favorable report from Col. Farquhar, in which he stated that seven suitable sites for reservoir dams had been found, capable of retaining about 95,500,000,000 cubic feet of water, a result somewhat different in detail from the first report, though with the exception of the estimated cost still more favorable.

The seven proposed reservoirs were, in detail, as follows:

Location.	Height of proposed dam.	Length of dam.	Area of watershed.	Probable capacity (in billions.)	Estimated cost.
	Feet.	*Feet.*	*Sq. miles.*		
Leech Lake	4	4,000	1,001	19⅓	$177,556
Lake Winibigoshish	14	1,000	1,892	36⅔	59,970
Mud Lake	6	600	161	3	31,737
Vermilion River	10	850	432	8⅔	56,245
Pokegama Falls	7	400	179	3⅓	75,334
Gull River	12	442	272	5¼	25,786
Pine River	24	592	551	10⅓	32,386
Mille Lacs	13	600	444	8⅔	29,537
Total				95½	488,551

With the survey of 1874, and the subsequent report, operations were suspended, and nothing further was done until 1878.

It may be mentioned here that four of the proposed dams will probably never be built. Those at Mud Lake and Vermilion River, it was afterwards determined, could be dispensed with by raising the dam at Pokegama Falls, and holding the water at that point.

The proposed dam at Gull River will probably be abandoned on account of the excessive damages asked for overflowed lands. At Mille Lacs the area of the watershed is so small, in proportion to the area of the lake, that the conclusion was reached that a head sufficient to produce a good discharge could not be obtained.

In July, 1878, Col. Farquhar was succeeded by Maj. Charles J. Allen, and about the same time an appropriation was made for continuing the surveys.

In addition to the completion of the work on the upper Mississippi River, the watershed of a considerable portion of Wisconsin was that year included in the examination, embracing all of the important streams discharging into the Mississippi River above Lake Pepin, the St. Croix, Chippewa, and Wisconsin rivers and their numerous tributaries.

The work on the upper Mississippi River in 1878 consisted mainly in the survey of the proposed dam sites, going more into detail than was possible in 1874, with borings at the proposed sites, gaugings to determine high and low water discharges, and observations on local precipitation and evaporation.

In Wisconsin the work was of about the same character as that on the Mississippi in 1874, the examination of localities favorable for the retention of water and sites for dams, etc.

The examination in Wisconsin was continued to completion in 1879, with the result of the selection of thirty-four favorable sites for reservoirs and dams.

Compared with the proposed reservoirs on the Mississippi River, those proposed on the Wisconsin River were comparatively small, there being only two that could retain 7,000,000,000 cubic feet of water; the remainder ranging from 400,000,000 cubic feet upward. The total capacity was, however, about 79,000,000,000 cubic feet, only about 15,000,000,000 less than the quantity claimed for the Mississippi River system.

The proposed reservoirs in Wisconsin were distributed as follows:

On the St. Croix and tributaries, fourteen, capable of retaining 34,000,000,000 cubic feet, with a watershed of 5,012 square miles. The total supply from the watershed was estimated at 98,000,000,000 cubic feet. There would, therefore, have been a surplus on the St. Croix of about 65,000,000,000 cubic feet.

The 34,000,000,000, that could have been retained, would have furnished 4,415 cubic feet of water per second for ninety days.

The cost of the fourteen dams was estimated at $385,720.

The rainfall of the St. Croix basin averaged about 25 inches, of which 0.7 of a foot was estimated as available.

On the Chippewa River and tributaries twelve dam sites were located, capable of retaining about 25,250,000,000 cubic feet, sufficient to furnish 3,246 cubic feet per second for ninety days. The watershed contained 5,513 square miles with the average rainfall at 30 inches, of which one-third was estimated as available. The total supply from the Chippewa Basin would have been about 127,333,333,333⅓ cubic feet, leaving a surplus over the capacity of the proposed reservoirs of about 102,000,000,000 cubic feet. Estimated cost of the dams on the Chippewa and tributaries, $325,530.

On the Wisconsin River eight favorable dam sites were located, capable of retaining 19,500,000,000 cubic feet of water, sufficient to furnish 2,488 cubic feet per second for ninety days.

From the watershed of 1,410 square miles the total supply from one-third of a 30-inch rainfall was estimated at about 32,000,000,000 cubic feet, sufficient to fill the proposed reservoirs and leave a surplus of 12,000,000,000 cubic feet. The cost of the eight dams on the Wisconsin River was estimated at $170,978.

The combined results of the construction of the thirty-four dams in Wisconsin would have been the retention, during average years, of about 79,000,000,000 cubic feet of water, sufficient to furnish 10,149 cubic feet per second for ninety days, at an estimated cost of $882,208.

These dams, if built, would probably have been constructed of wood and earth, something after the plan of Winnibigoshish, as described further on.

The lengths of the proposed dams varied from 75 feet to 2,500 feet, the heights from 6 feet to 41 feet. In some cases, in addition to the dams proper, extensive dikes would have been required to hold the water.

Some further examinations were made in 1880–'81, including final surveys of the proposed Gull Lake and Pine River reservoirs, a resurvey of the Pokegama country for a 24-foot and 30-foot dam, previously mentioned, and in Wisconsin examinations were made at a number of points, including Rock River, the Horicon Marshes, etc. The examinations of 1874 and 1878, in Minnesota, and 1878 and 1879, in Wisconsin, had,

however, pretty well covered the ground, and no other reservoir sites were found that were worth considering.

In addition to the operations so far outlined, as the investigations were continued, meteorological and hydrological data were required, so that reasonably fair estimates might be made as to the capacity of the reservoirs required to hold the surplus water, or, in other words, how much surplus water there would probably be to hold.

By the term "surplus water" was meant the excess over and above the mean low, water discharge, for in no case was it considered expedient to calculate on retaining any more than the excess or flood discharge.

Fortunately it had been the custom at military posts in this section of the country to measure and record the rainfall, and all this information, which was easily obtained, was very valuable in arriving at the average precipitation.

At Fort Snelling the record had been kept from 1837 to 1877; at Fort Ripley, from 1850 to 1876; at Fort Ridgely, from 1855 to 1864; at Fort Pembina, from 1872 to 1877; at Fort Abercrombie, from 1861 to 1872; at Fort Winnebago, from 1837 to 1843; and at Fort Howard, from 1836 to 1851. Records had also been kept at St. Paul from 1872 to 1878 and at Duluth from 1873 to 1877.

All of these points were quite favorably located for the section of country under examination, so that, to start with, a very fair idea of the average precipitation was obtainable. No attention, however, worth mentioning had been paid to evaporation or loss by absorption into the soil, and the proportion of the rainfall that reached the streams was at that time in this section of the country an unknown quantity.

Naturally, during the surveys the quantity of water moving was measured as often as possible, but the periods were short and a few gaugings did not go far toward determining the range of the streams.

Commencing with 1878, instruments were furnished survey parties for measuring rainfall and evaporation, and regular stations were established as near the proposed reservoirs as possible, for the same purpose—at Red Lake, Leech Lake, White Earth, Wausau, Crow Wing, and Taylors Falls.

At Crow Wing, on the Mississippi River, and at Taylors Falls, on the St. Croix, regular gauging stations for the purpose of taking daily measurements were established. At Crow Wing separate gaugings were made of the Mississippi and Crow Wing rivers; at Taylors Falls, of the St. Croix only. These measurements were continued for just one year—October, 1881, to November, 1882.

The basin of the Mississippi River above Crow Wing contained 7,283 square miles. The measurements showed that 151,644,239,424 cubic feet of water passed Crow Wing during the year, an average discharge of 4,791 cubic feet per second.

The minimum discharge was 1,905 cubic feet per second, on February 25, 1882; the maximum 10,837 cubic feet per second, on May 23, 1882.

The average rainfall at the four stations nearest to the basin, Moorhead, Leech Lake, Duluth, and Crow Wing, was 32.65 inches. The measured discharge as given showed that about 9 inches of the rainfall (a little less than one-third of the total precipitation) reached the river that year. Incidentally it should be mentioned that 1881 and 1882 were years of unusually large precipitation. There were floods on the lower river both years.

The basin of the Upper Mississippi River is generally sandy, with large marsh and lake areas. Clay, when found, is at considerable depths, and there is but little rock in place.

The slope of the Upper Mississippi River averages about 0.49 of a foot per mile.

The Crow Wing basin contained about 3,576 square miles. The observed rainfall at three stations, Moorhead, Leech Lake, and Crow Wing, averaged 30.85 inches.

The measured discharge for the year was 101,641,592,448 cubic feet, an average of 3,200 cubic feet per second. Maximum discharge, 10,160 cubic feet per second, May 13; minimum discharge, 891 cubic feet per second, February 23, 1882.

The discharge in this case showed that a little over 12 inches, about 40 per cent of the rainfall, reached the river.

The basin of the Crow Wing has more clay and less sand than that of the Mississippi River and the lake and marsh areas are less extensive. The slope of the Crow Wing averages 1.25 feet per mile.

The basin of the St. Croix River contains 5,950 square miles. The measured rainfall at two stations, Duluth and Taylors Falls, averaged 32.58 inches. The measured discharge during the year was 224,918,931,168 cubic feet, showing that nearly 50 per cent reached the river.

The maximum discharge was 35,775 cubic feet per second, May 13, 1882; the minimum 2,523 cubic feet per second, January 25, 1882; the average for the year, 7,100 cubic feet per second.

In the basin of the St. Croix there are large areas of rock in place on the upper tributaries, and there are also extensive marsh areas. Lower down there are large tracts of sandy soil of considerable depths in some places; in others alluvial soil with clay subsoil.

The slope of the St. Croix River averages about 3.33 feet per mile.

The general characteristics of the several basins under examination have been mentioned on account of the considerable difference in the observed results.

Prior to these investigations it had been assumed that one-third or more. likely one-fourth, of the rainfall could be estimated as available. In this case the facts proved to be more favorable than the original estimates.

The results obtained are not, however, in any way remarkable. Similar observations in other localities, mostly in the eastern States, go to show that all the way from 25 to 75 per cent of the rainfall reaches the streams.

Long-continued observations also prove that there are considerable variations in the same localities, under different conditions. As a rule, the smaller the precipitation the smaller the percentage that reaches the streams. On the other hand, the greater the slope of a river the greater the percentage of the precipitation that reaches it.

As to the loss from evaporation in open reservoirs, the results of the investigation in that direction proved that in this section of the country there was an average loss of about one-tenth of an inch per day during the six warmer months, and very considerably less during the remaining six months, the total loss being probably a little less than the average rainfall on the area exposed—about 27 inches.

As the exposed areas of the reservoirs and the discharging river are, in every case, very small in proportion to the areas of the watersheds, this loss was considered to cut a very small figure in the calculations. It was simply assumed that the rainfall and evaporation on the exposed water surfaces were equal.

June 14, 1880, an appropriation of $75,000 was made for the construction of an "experimental dam" at Lake Winnibigoshish. It was, however, over a year later, in December, 1881, before the work was actually commenced.

In the meantime, among other preparatory arrangements, a plan was prepared which was submitted to a Board of Engineers appointed by the Chief of Engineers for that purpose.

The plan as adopted, and after which the dam was finally built, was substantially as follows:

The body of the dam consists of an earth embankment 10 feet wide on top, 20 feet high above low water, with a slope of 2 feet to 1 foot in both back and face. The slopes and top are covered with a layer of clay 2 feet thick, protected on the face and top by a layer of stone 18 inches thick. On the back the layer of clay is covered with a heavy sod, protected as far up as it is liable to be affected by backwater, by a layer of stone as on the face.

A center core of puddled clay, 5 feet thick at the bottom, extends the full length of the embankment and there is a timber diaphragm running through the center of the puddle wall.

Before the embankment was built the area to be occupied was inclosed by sheet-piling, and the surface material, mostly muck, was removed to a depth of about 6 feet. On completion of the work these rows of sheet-piling were left in place as an additional protection to the bank. The portion of the dam occupied by the sluices is composed of crib work, filled with stone, supported at each end by crib abutments also filled with stone.

There are twenty discharge sluices 5 feet square and one 6-foot log sluice. The log sluice extends to the top of the dam, and is provided with an adjustable bottom, that can be raised or lowered to suit the stage of water in the reservoir.

Below the sluices, between the downstream extensions of the abutments, there is an apron 120 feet long; a wall of cribwork across the lower end forms the whole into a big swash basin, for the purpose of breaking up the destructive force of the water below the dam.

The timber portion of the dam is supported on piles. There are five rows of sheet piling under this part of the work, three under the main wall and abutments, and two at the extremities of the aprons. There is a short apron extending to the end of the abutments above the sluices.

The sluices are operated by timber gates working in grooves, controlled by hoisting machines on top of the wall over each gate.

The work on this dam was commenced in the latter part of December, though a party was started out a month earlier for the purpose of repairing the existing roads and bridges and swamping new roads.

The work during the winter consisted in getting supplies of all kinds, including subsistence, tools, machinery, etc., to the works. Nearly a year's supply was necessary, as the roads were impracticable except during the winter, building quarters and getting out logs for the lumber required in the dam. One million five hundred and ninety-one thousand feet, B. M., of logs, and 1,500 piles were cut and banked during the winter.

The logs were towed to dam site as soon as the lake opened, and were sawed into lumber by the sawmill that had been erected for the purpose. A steamboat, built

above Pokegama Falls the preceding year, was purchased and used in connection with the lumbering operations. The first pile was driven April 22, 1882. The dam was completed in August, 1884.

Leech Lake Dam was commenced in September, 1882. The preliminary operations were much the same as at Winnibigoshish, quarters were built, logs cut and banked, piles cut and hauled to the work, etc.

This dam is 3,600 feet long, 2,600 feet of embankment, and 1,000 feet of timber dam on pile foundation. The timber portion of the dam is simply a row of open sluices. The walls are of 12-inch by 12-inch timbers. The sluices are 6 feet wide and 12 feet long, open at the top, excepting the stringers that tie the walls together and the footway for the dam tenders.

The discharge is controlled by stop plank working in grooves. The timber portion of the dam is supported by three rows of piles. Leakage under the dam is prevented by two rows of sheet piling.

The embankment is formed of sand and gravel covered with sod and faced with stone.

In the center of the embankment there are two rows of sheet piling about 7 feet apart, supported by capped piles. The space between the rows of sheet piling is filled with selected material found in the locality, a mixture of clay and sand.

The bank is 9 feet wide on top, slope on the face of the dam 2 to 1; on the back 1¼ to 1. Top of bank 4 feet above flowage line. This dam will raise the lake 6 feet above the low-water stage.

Pokegama Dam was commenced in June, 1883. It is built on the same general plan as that of the timber portion of the Winnibigoshish Dam, timber cribs filled with stone, with the exception that, there being rock in place at Pokegama, the cribs were built on and secured to the rock, concrete being used to fill up the irregularities and bed the bottom timbers. Length of dam 380 feet, width 26 feet. There are thirty discharge sluices 5 feet by 4 feet, and an 8-foot log sluice.

The log sluice is operated by a Parker-Tainter gate, the discharge sluices by ordinary timber gates working in vertical grooves, controlled by gearing at the top of the dam.

Pokegama Dam was completed in October, 1884.

Pine River Dam.—The construction of Pine River Dam was commenced in February, 1884. The length of the dam is 1,500 feet; 235 feet of timber cribs filled with stone, and 1,265 feet of embankment.

The bank has a diaphragm of timber in the center of a puddle wall, similar to that at Winnibigoshish. The crib work is supported by piles. There are six rows of sheet piling. The space between two of the rows of sheet piling is filled with puddled clay capped with concrete. The spaces under the floor and between the cap timbers are filled with mortar cement, injected.

In addition to the dam proper, a dike 167 feet long and 13 feet high was built at a low point in the ridge surrounding one of the main lakes in the reservoir. The water is raised 17 feet by this dam. There are 13 discharge sluices 4 feet by 4 feet and one 10-foot log sluice. The latter is so arranged with stop plank, working in grooves, that the logway can be adapted to any stage of water in the reservoir. The dam was completed November, 1886, at a total cost of $90,388.92. The completion of the Pine River Dam brought the construction operations to a close.

One more dam is contemplated on the Mississippi River at Sandy Lake, and it is proposed to raise Pokegama Dam 2 feet. The proposed change at Pokegama will so much increase the capacity of that reservoir as to do away with the necessity for the proposed dams at Mud Lake and Vermilion.

From the latest revision of the estimates, the four dams now in operation are capable of retaining about 77,000,000,000 cubic feet of water.

Leech Lake Reservoir	22,000,000,000
Lake Winnibigoshish Reservoir	45,000,000,000
Pokegama Reservoir	3,000,000,000
Pine River Reservoir	7,000,000,000
Total	77,000,000,000

sufficient to furnish about 10,000 cubic feet per second for ninety days.

With the proposed dam at Sandy Lake and the change at Pokegama the capacity of the holding grounds will be increased to about 83,000,000,000 cubic feet, sufficient to furnish 10,700 cubic feet per second for ninety days.

Of course it would probably be out of the question, under any circumstances, to discharge 10,000 cubic feet or more per second from the reservoir dams; the quantity mentioned is merely intended to give an idea of the value of 83,000,000,000 cubic feet of water as expressed in a supply for a given period of time.

The conditions thus far have not been favorable for the retention of very large quantities of water. Eighteen hundred and eighty-two was the last high-water

year; 1883, 1884, 1885, and 1886 were unusually dry, and in 1887, though there was about the average rainfall, the entire country had become so thoroughly dried out that the proportion of rainfall that reached the lakes and rivers was very much less than the usual supply. The two main reservoirs—Leech Lake and Lake Winnibigoshish—were first closed for the retention of water in the spring of 1884. They have, consequently, had the full benefit of the drought. From other causes, in addition to the drought, the retention of large quantities of water has to an extent been interfered with.

In the original calculations on the amount of water available for storage purposes, as previously mentioned, the mean discharge of the streams affected was allowed for, and it was believed that such quantity would be sufficient to meet all requirements except at such times as it would be necessary to permit the flow of water for the benefit of navigation. Since the construction of the dams that has not, however, been the case, or, at any rate, has not been considered so by those interested in various enterprises on the lakes and rivers in the reservoir country, and demands have been made from every side for more water. One of the main causes of loss has been, so far, the water required to sluice logs at times when additional water was not required for the purposes of navigation.

Another has been the construction of a large number of small dams on the minor tributaries by the lumbermen. None of these dams retain any very large quantity of water, but in the aggregate the amount is sufficient to materially affect the main river, and the consequence is that more water from the reservoirs is required to keep up the mean discharge. Demands have also been made by the millers at Minneapolis and by the steamboat men on the upper river for more water for their interests. As a rule they did not get it, but the result has been, more water has been furnished than was originally expected would be necessary, rather than involve the Government in endless claims for damages.

The attention of the General Government has been called to this feature of the case, and legislation has been asked for, which may define the rights of all parties, and in all probability the entire arrangement will soon be controlled by special laws.

In Wisconsin the lumbermen were at first very enthusiastic on the question of Government reservoirs; but of late years they have, however, obtained control of most of the important streams, and it is believed that, recognizing the fact that their interests can not help being more or less antagonized by the retention of water for the benefit of navigation, they are now to a great extent opposed to their construction. In all probability this opposition is the cause of the work not having been started in that State.

In spite, however, of the somewhat unfavorable conditions under which the completed reservoirs have so far been operated, the results have been very encouraging, and foreshadow what can probably be done under reasonably favorable circumstances. As previously mentioned, the two main reservoirs—Leech Lake and Lake Winnibigoshish—were first closed for the retention of water in the spring of 1884, the first on the 14th of March, the latter on the 3d. Leech Lake Dam was kept closed, or rather partially closed, until about the middle of July. During that period the lake was raised about 1.4 feet, indicating an accumulation of about 6,000,000,000 cubic feet of water. Commencing on the 19th of July, a steady flow of water was permitted until the 13th of October. The discharge in July was 600 cubic feet per second. From the 1st of August until the 13th of October the average discharge was about 500 cubic feet per second. The ordinary low-water discharge of Leech Lake is less than 300 cubic feet per second.

Lake Winnibigoshish Reservoir was kept closed until June 15. The lake was raised 2.3 feet; an accumulation of about 6,000,000,000 cubic feet of water. From the 15th of June until the 20th of October a steady discharge was permitted. In June and July the discharge averaged 1,000 cubic feet per second; in August, 700 cubic feet per second; in September, 670 cubic feet; in October, until the dam was closed, 450 cubic feet per second. The low-water discharge at Lake Winnibigoshish is about 450 cubic feet per second.

Briefly summarized, the operation of the dams in 1884, a very dry year, resulted in the accumulation of about 12,000,000,000 cubic feet of water during an average period of 115 days. Leech Lake 127, Winnibigoshish 104, and after the dams were opened the furnishing of a supply for at least one-half the period of discharge of about double the usual supply for the time of year. The first year's accumulation was not expected to amount to much. A considerable quantity of water was released from the reservoirs for various purposes before the regular discharge was commenced, and as Pokegama Dam was still unfinished, no attempt was made to accumulate or to discharge any very large quantity of water that year.

During the following winter all of the dams were partially closed, only sufficient water being allowed to pass to keep up the usual winter discharge at Pokegama—between 400 and 500 cubic feet per second. When navigation opened in the spring

of 1885 the discharge from Pokegama was increased to about 1,000 cubic feet per second, sufficient for the purposes of navigation on the upper river, no water at that time being required on the river at and below St. Paul; and as most of this 1,000 cubic feet per second came from Pokegama Reservoir, a considerable quantity of water was allowed to accumulate in the upper reservoirs.

The river at and below St. Paul in the early summer of 1885 was at a very low stage, and it was concluded to make an experimental discharge from the reservoirs. This was expected to begin early in July, but from various causes—among others the probable damage to certain hay lands below Pokegama, which seemed likely to develop claims for damages—the discharge was not commenced at Pokegama until the 15th of August.

The dams at Winnibigoshish and Leech Lake were, however, opened about the 1st of August to permit the accumulation of a considerable quantity of water in the Pokegama Reservoir prior to the proposed discharge. Up to that time, the 1st of August, the rise in Leech Lake Reservoir had been about 3 feet, indicating an accumulation of about 15,000,000,000 cubic feet of water; and in Winnibigoshish about 7 feet, an accumulation of about 20,000,000,000 cubic feet. The discharge in August from Leech Lake averaged 1,200 cubic feet per second; in September, 1,000 cubic feet; in October, 450 cubic feet. From Winnibigoshish, in August, the discharge averaged 2,000 cubic feet per second; in September, 1,800 cubic feet; in October, 1,000 cubic feet. The greatest quantity of water passed at one time was about 3,200 cubic feet per second from the Winnibigoshish Reservoir in August.

At Pokegama, the distributing reservoir, up to the 15th of August, the discharge had been kept up to about 1,000 cubic feet per second. On that date the water from the upper dams commenced to arrive in large quantities, and the discharge was rapidly increased. During the remaining fifteen days of August the average was about 2,700 cubic feet per second; in September the average was about 3,000 cubic feet; in October, 2,800 cubic feet; and during the first fifteen days of November, 1,700 cubic feet, per second.

The greatest discharge was 3,200 cubic feet per second for several days during the latter part of September. After the 15th of November the discharge was reduced to the usual winter supply for the lower river.

In 1886 the accumulation of water in Leech Lake was about 15,000,000,000, as indicated by a rise of 2.8 feet up to the 1st of July. The discharge, in August, was about 1,000 cubic feet per second; in September, 750 cubic feet; and in October, up to the 15th, about 700 cubic feet per second.

Large quantities of water had, however, been drawn from the lake in June and July prior to the regular discharge that was commenced in August for the purpose of keeping up a navigable stage on the upper river, which was that year at a very low stage.

In Winnibigoshish the accumulation was about 22,000,000,000 cubic feet, as indicated by a rise of 7½ feet in the lake. During June the discharge was about 1,100 cubic feet per second; in July and August, about 2,000 cubic feet; in September, 1,600 cubic feet, and in October, about 800 cubic feet, per second. By the 1st of November the head in the lake had been reduced about 6 feet.

At Pokegama, the discharge, in June, averaged about 1,800 cubic feet per second; in July, 1,600 cubic feet; in August, 2,200 cubic feet; in September, 2,400 cubic feet; in October, 1,900 cubic feet, and in November, 1,200 cubic feet per second.

The Pine River dam having been completed and closed in the spring of 1886, a discharge from that reservoir was added to the discharge from the upper reservoirs. Up to the 1st of June there was a rise in the reservoir of 6¼ feet. During the month of May, there was a discharge of 600 cubic feet per second; in June, 500 cubic feet; in July, 400 cubic feet; in August, 250 cubic feet; in September, 150 cubic feet per second. The low-water discharge of Pine River is about 150 cubic feet per second.

In 1887 up to the 1st of August, there was an accumulation in Leech Lake of about 10,000,000,000 cubic feet. This water was let out as follows: In August, 550 cubic feet per second; in September, 475 cubic feet; in October, 425 cubic feet per second.

At Winnibigoshish the accumulation was about the same—10,000,000,000 cubic feet. The discharge, in August, was 1,500 cubic feet per second; in September, 1,000 cubic feet; in October, 800 cubic feet per second.

The comparatively small accumulation and discharge from Leech Lake and Winnibigoshish was caused by the heavy drafts that had been made on the reservoirs during the months preceding those above mentioned, mainly to keep the upper river up to a navigable stage and to an extent for the movement and sluicing of logs.

At Pokegama, the discharge from May 1 to August 1 averaged about 1,100 cubic feet per second. In August, 1,875 cubic feet; in September, 1,800 cubic feet, and in October, 1,500 cubic feet per second.

At Pine River Reservoir there was an accumulation of about 2,500,000,000 cubic feet, as indicated by a rise of 7 feet. During the last ten days of June a discharge was

permitted of 600 cubic feet per second; in July, 530 cubic feet; in August, 558 cubic feet; in September, 363 cubic feet, and in October, 204 cubic feet per second.

The foregoing brings the operation of the reservoirs up to date. I have gone somewhat into the details of the operations at each reservoir, to show when and where the water was accumulated and how it was disposed of. In considering the results it will only be necessary to refer to the discharges from Pokegama and Pine River.

Now, as to what has, so far, been accomplished by the reservoirs.

In 1885, the first year in which any considerable discharge was made, the discharge from Pokegama during the last 15 days of August was 2,700 cubic feet per second; in September, 30 days, 3,000 cubic feet per second; in October, 31 days, 2,800 cubic feet per second; and in November, 30 days, 1,700 cubic feet per second. The mean low-water discharge of the Mississippi River at Pokegama, is about 850 cubic feet per second, as determined by long-continued observations at that point. This quantity was all that could reasonably have been expected, under the existing circumstances of rainfall, etc., during the months of August, September, October, and November. It is reasonable to suppose, therefore, that the reservoirs added to the low-water discharge of the river during the last 15 days of August 1,850 cubic feet per second; in September, 2,150 cubic feet per second; in October 1,950 cubic feet per second; in November, 850 cubic feet per second; an average of nearly 2,000 cubic feet per second for the first 76 days, or an average of 1,775 cubic feet per second for the entire 107 days.

The mean low-water discharge at St. Paul is estimated at about 5,000 cubic feet per second. Consequently the quantity of water supplied was equal to 40 per cent of the low-water discharge at St. Paul for the first 76 days.

In 1886 the discharge was commenced in May with 600 cubic feet per second from Pine River and about 1,000 cubic feet per second from Pokegama; in June, the joint discharge was 2,300 cubic feet per second; in July, 2,000 cubic feet; in August, 2,450 cubic feet; in September, 2,550 cubic feet; in October 1,900 cubic feet, and in November, 1,200 cubic feet per second from Pokegama only.

Figuring on the basis that the low-water discharge was all that could have been expected but for the reservoirs, and this was even more true, if possible, in 1886 than in 1885, for that year the precipitation was probably less than any year since 1864, the phenomenally low-water year, the addition to the supply for the lower river was as follows: In May, 450 cubic feet per second from Pine River and 150 cubic feet per second from Pokegama; in June, 1,300 cubic feet per second from the two reservoirs; in July, 1,000 cubic feet per second from the two reservoirs; in August, 1,450 cubic feet per second from the two reservoirs; in September, 1,550 cubic feet per second from Pokegama only; in October, 950 cubic feet per second from Pokegama only; in November, 350 cubic feet per second from Pokegama only; an average supply over and above the mean low-water discharge from the 1st of June to the 1st of November, a period of 153 days, of 1,255 cubic feet per second, just about one-quarter the low-water discharge at St. Paul.

In 1887 operations were commenced by discharging 1,100 cubic feet per second from the Pokegama Reservoir in May. In June the discharge from Pokegama was 1,100 cubic feet per second and for the last ten days of the month 600 cubic feet per second from Pine River Dam. In July the discharge from both reservoirs was 1,630 cubic feet per second; in August, 2,433; in September, 2,163; and in October, 1,700 cubic feet per second.

Figuring on the same basis as in 1885 and 1886, the extra supply in July was 630 cubic feet per second; in August, 1,433 cubic feet; in September, 1,163 cubic feet, and in October, 700 cubic feet per second. The average extra supply from the 1st of July to the 1st of November, 123 days, was about 1,000 cubic feet per second, one-fifth of the mean low-water discharge at St. Paul.

The decrease in the supply from 40 per cent of the low-water discharge at St. Paul in 1885 to 20 per cent of the same in 1887 was in part caused by the longer period of discharge, but mainly by the continued drought, as the quantity of water stored in the reservoirs during the usual high-water period steadily decreased. The effect of the flow of water from the reservoirs during the several discharges was noted on gauges established at various points on the river below.

At the time of the discharge in 1885 all of the tributary streams between this city and Pokegama Falls were known by actual measurements and observations to be steadily falling, and the river at St. Paul was also falling at the rate of a tenth of a foot per day. The fall at St. Paul continued for eight days after the discharge at Pokegama was commenced, showing that that was about the time required for the water to pass over the 391 miles between this city and the main distributing dam. The gauge records give the best idea of the progress and effect of the discharge. From the observed effect at St. Paul and the series of observations made at the time it is believed that the discharge of that year added at least 1¼ feet to the stage of water at St. Paul. During the time of discharge there were no rains that could have produced any material effect on the river.

The conclusion of a board of engineers appointed by the Chief of Engineers was that the extra 2,000 cubic feet per second supplied to the river at Pokegama in 1885 caused an increased depth at St. Paul of 0.96 of a foot; at Hastings, 27 miles below, 0.87 of a foot, and the effect of the discharge practically ended at Winona, 125 miles below St. Paul, with a rise of 0.06 of a foot.

This report, it is believed, was a very conservative one and did not give the reservoir question the benefits of any doubts whatever. As for loss from any cause, such as evaporation or infiltration, the conclusion of the board was that such loss could not exceed 5 per cent of the amount furnished at Pokegama.

As a result of a series of observations during low stages, it has been proved that an increase of 100 cubic feet per second will cause a rise of 0.1 foot at St. Paul.

It is unfortunate for the reservoir question that so little of the river above St. Paul is navigable, for on that portion, naturally, the greatest effect of the water from the reservoirs has been exhibited. At Grand Rapids, in 1885, during the discharge there was a rise of 5.2 feet, and at Aitkin, 165 miles below, a rise of 3 feet and a proportional rise to the Falls of St. Anthony. This effect, as may be noticed on the gauge sheet, was continued during the entire discharge. Of this portion of the river, only 165 miles is at present operated on by steamboats, and consequently the resulting benefits have not been appreciated to the full extent.

The results from the reservoirs may not seem very large, but when it is considered that what has been done has been accomplished by the construction of only four reservoir dams, and that storage operations have so far been carried on through four years of unusually low water, the results are encouraging, if not phenomenal.

The greatest accumulation at any one time was about 35,000,000,000 cubic feet in 1885; with that accumulation the two main reservoirs were just about half full. With the reservoirs full (and there is no reason to suppose but that they can be easily filled when the rainfall gets back to its normal condition), there is every reason to believe that everything that has been claimed for the system, as far as built, will be realized.

Respectfully submitted.

R. DAVENPORT,
Assistant U. S. Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

Z 3.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The plan for improvement of the Chippewa River consists in revetment of caving bends and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 57 miles, to confine the low-water volume to a channel of nearly uniform width and depth. The general plan for improvement was adopted in 1877, and the work has been carried on in accordance with it, varying, however, more or less, as to location and extent of dams, jetties, etc.

The object of protection of the Yellow Banks is to prevent erosion of the high sand bluffs or banks bordering the Chippewa River at a number of points below Eau Claire, and to thereby relieve the channels of that river and of the Mississippi below the junction of the two streams from the masses of sand contributed by those banks. The plan for protection consists in a revetment of piling and fascines, the latter to be crowned with rock.

The examination of the river upon which the plan and estimate were based was made in 1874. The report, dated January 30, 1875, of this examination, is printed in Part I, Appendix to the Annual Report of the Chief of Engineers, pages 375–380. In that report the estimate of

the cost of improvement, including protecting the Yellow Banks, was $139,892.50.

The first appropriation for improving the Chippewa River was made in 1876, and the first for protection of the Yellow Banks was made in 1882. These were regarded as separate and distinct works until the act of Congress of August 11, 1888, appropriated for the improvement of the Chippewa River, including Yellow Banks in said river, Wisconsin, continuing improvement, $10,000.

The estimated cost, including all expenditures since 1876, for channel improvement of the river, as revised by my predecessor in 1888 (see pages 1543, 1544, Annual Report for 1888), was placed at $176,487.72. The cost of protecting the Yellow Banks, as revised by the same officer in 1883 (see page 1443, Annual Report for 1883), was estimated at $96,000, making the total cost for channel improvement and the protection of the Yellow Banks $272,487.72.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth. Frequently the depth of water on the bar at the mouth of the river was but 10 or 12 inches.

The work of improvement to June 30, 1891, has provided a permanent channel, 3 feet in depth, over the bar at the mouth of the river and materially increased the depth over the Durand, Plum Island, Battle Island, Wacouta Island, and Flowerpot Island bars, besides straightening a difficult piece of river at the Madison Street Bridge in Eau Claire, and the stoppage of a dangerous cut-off at Dead Lake. Where the improvements have been completed the channels are 3 feet or more in depth. The channel improvements have effected a reduction of 10 cents per thousand in the cost of running rafted lumber from Eau Claire to the mouth of the river.

No work of consequence has been done at the Yellow Banks since 1883. At that time revetments of the banks had been accomplished as follows:

At Waubeek Bank, 2,989 feet long, protection completed.

At Rumseys Bank, 4,500 feet long, piles all driven and 1,850 linear feet of protection completed.

At Mary Dean Bank, 6,900 feet long, piles have been driven for 625 linear feet and 139 feet of the protection completed.

Total expended from commencement of operation in 1877 to June 30, 1891, including outstanding liabilities, $157,407.66.

Operations during the past fiscal year.—Operations were commenced last fall and continued until March, 1892. A pile boom at Dead Lake Cut-off was built to protect the dam at that place from the wearing action of loose logs.

Plum Island Flats dam No. 2 (1,000 feet) was built and three foundation courses of brush and stone of the main portion (500 feet) of Plum Island Flats dam No. 3 were laid. Soon after the ice went out in the spring high water occurred, and the river has since remained at a high stage, so that the effect of last winter's work on the low-water channel could not be demonstrated; but it is believed that the result will be beneficial to navigation interests.

During the year two bridges spanning the river have received official attention. The first, the Red Cedar Crossing of the Chicago, Milwaukee and St. Paul Railway, is being rebuilt, and the company de-

sired to make certain alterations, which, after an examination and report by me, were approved by the Secretary of War.

The second was the highway bridge at Durand, Wis., against which complaints had been made at various times. Under the provision of the act of Congress approved September 19, 1890, a public hearing was given in the matter, and the Secretary of War ordered a boom to be constructed by December 15, 1892, to facilitate the passage of rafts.

The following statement shows the cost of work during the past year:

General expenses.

Care of property, repairs to boats, moving camp, etc., survey at Plum Island, superintendence, and St. Paul office expenses		$2,520.60
Sheer boom at Dead Lake cut-off		675.11
Plum Island Flats Dam No. 2:		
Clearing bar of loose logs and cutting ice around dam	$35.93	
858 cords brush in place, at $1.97	1,696.92	
220.1 cords stone in place, at $6.04	1,329.42	
585.5 cubic yards sand, at 20¼ cents	173.95	
1,000 linear feet of dam complete, at $3.24		3,236.22
Plum Island Flats Dam No. 3:		
Piling	384.95	
Clearing bar of loose logs and cutting ice around dam	50.14	
220.69 cords brush in place, at $1.94	427.37	
69¼ cords stone in place, at $5.05	381.13	
486.11 cubic yards sand, at 61¼ cents	261.42	
500 feet of foundation, at $3.01		1,505.01
Materials on hand: 85 cords brush, at 1.72\frac{7}{17}$		146.55
Bridges:		
Examination, etc., of Red Cedar Bridge	14.08	
Examination, etc., of Durand Bridge	69.55	
		83.63
Total expenses for the year		8,167.12

Mr. A. O. Powell, assistant engineer on this improvement, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

Expenses during the fiscal year ending June 30, 1892, including outstanding liabilities, $8,167.12.

The sum of $60,000 can be profitably expended during the fiscal year ending June 30, 1894.

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1891, amounted to $365,922.16.

Abstract of appropriations.

By act approved—	
August 14, 1876	$10,000
June 8, 1878	10,000
March 3, 1879	8,000
June 14, 1880	10,000
March 3, 1881	10,000
By act passed August 2, 1882	65,000
By act approved July 5, 1884	15,000
By act approved August 5, 1886	18,750
By act August 11, 1888	10,000
By act approved September 19, 1890	10,000
By act approved July 13, 1892	5,000
Total	171,750

Money statement.

July 1, 1891, balance unexpended	$9,435.87
June 30, 1892, amount expended during fiscal year	7,721.89
July 1, 1892, balance unexpended	1,713.98
July 1, 1892, outstanding liabilities	538.76
July 1, 1892, balance available	1,175.22
Amount appropriated by act approved July 13, 1892	5,000.00
Amount available for fiscal year ending June 30, 1893	6,175.22
Amount (estimated) required for completion of existing project	100,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1894	60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Comparative statement of lumber, laths, shingles, pickets, and logs for nine years.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total tonnage, exclusive of loose logs.	Beef Slough logs.
	Feet, B. M.	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet, B. M.*
1891	152,040,386	107,841,850	48,700,210	1,258,850	314,085	284,113,430
1890	166,477,966	46,234,673	78,499,500	1,222,989	342,350	606,992,790
1889	158,938,294	50,487,855	112,053,075	2,244,786	329,156	400,518,720
1888	161,309,512	50,544,370	86,348,900	1,500,320	325,971	542,437,000
1887	186,826,521	64,725,580	130,516,200	3,023,235	....	404,302,650
1886	207,205,672	77,729,630	158,645,750	1,934,340	....	465,000,000
1885	374,138,443	95,992,900	195,880,220	75,000,000	....	600,600,000
1884	298,344,591	88,905,520	160,133,000	1,840,278	....	534,674,176
1883	269,094,203	82,643,500	129,754,000	1,497,948	....	450,000,000
1882	375,000,000	66,000,000	150,000,000	2,200,000	....	350,000,000

Comparative statement of freight and passengers for nine years.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
		Pounds.				*Pounds.*	
1891	*1	....	....	1885	1	690,000	4,728
1890	*1	....	....	1884	2	1,500,000	5,500
1889	*1	....	....	1883	3	3,184,000	4,000
1888	1	....	....	1882	3	2,640,000	10,490
1887	1	600,000	1,400	1881	3	3,932,000	16,989
1886	1	....	4,700				

* One hundred and eight tons burden and 2 feet draft.

But one steamboat plied regularly on the river during the season of 1891. This boat, the *Phil. Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about halfway between the mouth and Eau Claire, to assist the Knapp, Stout & Co. rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

Z 4.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The original project for the improvement of this river, adopted in 1878, was based upon the results of a survey made in 1874, when the St. Croix was at a high stage of water and but comparatively few bars, etc., to be seen, and contemplated the removal of snags, bowlders, wrecks, leaning trees, and sand bars between Taylor Falls and Prescott, and contraction of low-water channel between Taylor Falls and Stillwater into one of nearly uniform width by means of brush and stone jetties and dams of the same material, to close island chutes and secondary channel. Estimated cost, $21,758.

The lower part of the river is a lake known as Lake St. Croix. Stillwater, at the head of the lake, divides the navigable portion of the river into sections: The upper or river section, $28\frac{1}{2}$ miles in length, and the lower or lake section, $23\frac{8}{10}$ miles in length.

The present project, adopted in 1880 and modified in 1882, and again in 1889 (see page 1801, Annual Report, 1889), by my predecessor, is based upon results of a low-water survey made in 1879. The estimated cost has been placed at $108,700.

In the Annual Report for 1889 he reported:

> The first appropriation for the improvement of the St. Croix was $10,000, made by act of Congress approved June 18, 1878.
>
> At that date the channel, above Stillwater especially, was encumbered by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The low-water channel had, in many places, but 2 feet of depth, and steamers and barges made their way as best they could amongst the obstructions. At times it was impossible for them to get over the shoal places. Under this appropriation some of the worst obstructions were removed between Taylor Falls and Stillwater.

The free navigation of the lower section was obstructed by partly sunken logs, and by the Hudson and Catfish bars, $6\frac{8}{10}$ and $15\frac{1}{10}$ miles, respectively, below Stillwater. The channel over the Hudson Bar was quite tortuous and shallow, having but $2\frac{1}{2}$ feet depth at low water. At Catfish the channel had sufficient depth, but made a sharp bend around a long, narrow sand spit that jutted out for a distance of 1,450 feet from the left bank and at right angles to the shore line. When a strong wind blew up or down the lake the steamboats with heavy rafts encountered considerable difficulty in keeping the channel.

The improvements to June 30, 1891, resulted in a decidedly improved channel above Stillwater to the advantage of the river traffic then existing. The improvement consisted in the removal of sunken cribs, wrecks, snags, old boom piers, and leaning trees, and construction of wing dams to contract the channel over the worst bars, and thereby increased the depth over the bars worked on from an original low-water depth of 2 to 3 feet.

Since 1886 the railroads penetrating the region have reduced navigation over this section to almost nothing, except the running of loose logs; as a consequence little attention during the past six years has been given to the improvement of this section.

On the lower section (Stillwater to the mouth) the commerce, consisting of rafted lumber and logs towed by steamboats, is of large proportions, and its needs are being met by expending the largest part of appropriations on this reach. By June 30, 1891, channels had been dredged through the Catfish and Hudson bars to a depth of 4 feet at low water, and the water directed into new channels by training dams.

Many of the partly submerged logs were also removed, but new ones are continually coming into the channel. The work has resulted in creating a fair steamboat channel, 4 feet deep at low water, from Stillwater to the mouth. Boats and rafts can now pass over that distance at the lowest stages; but some work remains to be done in widening the dredged channels and straightening other portions, particularly on the Hudson Bar above and below the bridge.

Expended under the present project to June 30, 1891, including outstanding liabilities, $80,717.94.

Total expended under original and present projects to June 30, 1891, including outstanding liabilities, $98,717.94.

Operations during the past fiscal year.—The balance of the appropriation of 1890 was expended in widening somewhat the channel over the Hudson Bar by dredging 334.13 cubic yards above the bridge and 547.15 cubic yards below the bridge. Log-house Dam, on the upper reach of the river, was repaired by placing on it 98.5 cubic yards brush and 217 cubic yards stone. Ninety-one snags and partly sunken logs were removed from the head of the lake and the river above. The work accomplished during the year has been small, owing to the lack of funds; but the dredging at Hudson Bar has improved the steamboat and raft channel.

Total expended during the fiscal year ending June 30, 1892, including outstanding liabilities, $1,743.08.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1891, $299,659.32; value of domestic exports for same period, $452,251.

Abstract of appropriations.

By act approved—		By act approved August 5, 1886	$7,000
June 18, 1878	*$10,000	By act of August 11, 1888	10,000
March 3, 1879	*8,000	By act approved September 19, 1890	8,000
June 14, 1880	10,000	By act approved July 13, 1892	8,000
March 3, 1881	8,000		
By act passed August 2, 1882	30,000		
By act approved July 5, 1884	9,000	Total	108,500

Money statement.

July 1, 1891, balance unexpended	$4,796.99
June 30, 1892, amount expended during fiscal year	4,747.55
July 1, 1892, balance unexpended	49.44
July 1, 1892, outstanding liabilities	10.46
July 1, 1892, balance available	38.98
Amount appropriated by act approved July 13, 1892	8,000.00
Amount available for fiscal year ending June 30, 1893	8,038.98
Amount (estimated) required for completion of existing project	18,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	18,200.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

* Appropriated before adoption of present project.

COMMERCIAL STATISTICS.

Comparative statement of steamboats and barges, freight and passengers carried, lumber and logs towed and rafted on the St. Croix River, Wisconsin and Minnesota, for a period of fourteen years.

STEAMBOATS AND BARGES.

Year.	In freight and passenger business.		Steamboats in towing and rafting business.	Year.	In freight and passenger business.		Steamboats in towing and rafting business.
	Steamboats.	Barges.			Steamboats.	Barges.	
1878*	3	....	8	1885	4	33	50
1879	3	....	12	1886	6	38	49
1880*	3	....	29	1887	3	40	58
1881	2	....	40	1888	1	3	58
1882	3	24	77	1889	1	3	52
1883	3	25	51	1890	2	3	126
1884	3	25	30	1891†	‡1	6	§130

* Amount of commerce and navigation when work of improvement began.
† Amount of commerce and navigation at present time.
‡ 117 tons burden and 18 inches draft, respectively.
§ From 35 to 240 tons burden and 2½ to 3½ feet draft.

FREIGHT AND PASSENGERS.

Year.	Freight carried.					Passengers carried.
	General merchandise.	Lumber.	Wood.	Total to 1887 inclusive.	Total.	
	Tons.	*Tons.*	*Tons.*	*Pounds.*	*Tons.*	
1878*	....	....	....	32,000,000	....	15,000
1879	....	....	....	47,786,995	....	9,244
1880	....	....	....	(†)	....	(†)
1881	....	....	....	35,000,000	....	11,015
1882	....	....	....	60,000,000	....	10,300
1883	....	....	....	63,000,000	....	12,800
1884	....	....	....	80,000,000	....	4,000
1885	....	....	....	85,000,000	....	10,647
1886	....	....	....	180,900,000	....	12,756
1887	....	....	....	57,009,320	....	9,872
1888	....	5,200	4,354	....	9,554	....
1889	....	5,900	4,100	....	10,000	....
1890	209	7,139	5,796	....	13,144	921
1891	....	100	200	....	300	551

* Amount of commerce and navigation when work of improvement began.
† Unknown.

RAFTED LOGS AND LUMBER.

Year.	Rafted logs towed out of St. Croix River (estimated).	Rafted lumber towed out of St. Croix River.				Total tonnage.
		Lumber.	Shingles.	Laths.	Pickets.	
	Feet, B. M.	*Feet, B. M.*	*Number.*	*Number.*	*Number.*	*Tons.*
1878	70,000,000	....	....	....	....	....
1879	117,000,000	....	....	....	....	....
1880	200,000,000	....	....	....	....	....
1881	185,000,000	....	....	....	....	....
1882	130,000,000	....	....	....	....	....
1883	108,000,000	....	....	....	....	....
1884	175,000,000	....	....	....	....	....
1885	150,000,000	....	....	....	....	....
1886	115,000,700	....	....	....	....	....
1887	175,000,000	100,000,000	....	....	....	....
1888	186,000,000	114,610,966	40,079,500	23,651,800	570,820	706,367
1889	150,000,000	81,817,070	38,633,000	23,226,575	90,800	697,244
1890	250,000,000	116,403,000	46,007,000	33,861,900	278,580	1,104,100
1891	209,233,490	110,934,064	32,016,750	31,132,350	678,240	948,757

Loose logs driven on St. Croix River to head of lake during season of 1891 were 315,231,300 feet, B. M., or 1,103,310 tons.

Z 5.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

An examination of this stream was made by Maj. G. K. Warren, Corps of Engineers, in 1866, under authorization of section 4 of the act of Congress approved June 23, 1866. Maj. Warren's first or preliminary report of this survey was rendered January 21, 1867, and printed as a part of Senate Ex. Doc. No. 58, Thirty-ninth Congress, second session.

The estimates of cost of improvement, based upon results of this examination and survey, are given in the Report of the Chief of Engineers for the year ending June 30, 1867. Two plans are considered, viz, one to improve the navigation of the river from the Yellow Medicine to the mouth of the Minnesota by means of locks and dams, so as to secure 4 feet of water, at a cost of $775,500, and another to secure 2 to 3 feet of water by removal of snags and bowlders throughout this stretch of the river, in addition to the construction of a lock and dam at Little Falls and the operation of a scraper and dredge boat, at a cost of $117,000.

The river and harbor act of Congress approved March 2, 1867, appropriated $37,500 for removing snags and bowlders throughout the Minnesota River, thus sanctioning the second plan.

The river and harbor acts of Congress approved June 11, 1870, and March 3, 1871, each appropriated $10,000 for continuing the improvement.

The second section of the river and harbor act of Congress approved June 10, 1872, provided for the survey of the Minnesota River above the mouth of the Yellow Medicine, which survey was made during the same year, the report pertaining to which is printed in the Report of the Chief of Engineers for the fiscal year ending June 30, 1873. The removal of obstructions, principally bowlders, was recommended.

The same act (approved June 10, 1872) appropriated $10,000 for the improvement of the stream, which sum was expended in the removal of bowlders, overhanging trees, etc.

By act approved March 3, 1873, there was appropriated—

> For the improvement of Minnesota River, Minnesota, $10,000; provided that one-half of said sum shall be expended between the mouth of the Yellow Medicine and Minnesota Falls on said river.

This appropriation was applied to the removal of rocky ledges, bowlders, snags, and overhanging trees. The total of appropriations to March 3, 1873, inclusive, was $77,500.

By act of Congress approved June 23, 1874, an appropriation of $10,000 was made "for the survey or improvement of Minnesota River." A survey was made from the mouth of the river to South Bend, a distance of 116.4 miles, to determine the practicability of improving the navigation by means of canals, locks, and dams. The results of this survey proved the possibility of a lock-and-dam navigation for the distance passed over, the estimated cost of improvement, as stated in the report of the survey printed in the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1875, being for five locks and dams and removal of snags, etc., $733,868.63, the cost of removing snags, etc., being therein placed at $34,585.10, including contingencies. Following this report, Congress made three appropriations, of $10,000 each, by acts approved March 3, 1875, August 14, 1876, and June 18, 1878, which sums were applied to clearing the river of obstructions below South Bend.

The appropriations up to and including that of June 18, 1878, were applied in removing snags, bowlders, etc., on the upper part of the river between Minnesota Falls and a point 30 miles below Henderson (16.7 miles above Shakopee). The rapidly caving banks on this stretch of the river add snags and leaning trees to the channel yearly, so that channels which were cleared twelve years ago are encumbered with them to-day.

No money has been spent on the lower part of the river, which presents a marked contrast to the upper section.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered possible by the improvement of the bar at the mouth of the river and an increased depth provided over Credit River Bar (or Petersons Bar, as it is sometimes called), just below Shakopee.

It is claimed by those interested in the Minnesota Valley that, were the improvements extended by the construction of locks and dams, steamboats and barges would navigate the river and carry much of the freight that now depends upon rail for transportation.

The river and harbor act of Congress approved August 5, 1886, authorized a survey of the Minnesota River with a view to its improvement by locks and dams. The survey, extending from the mouth of the river to Mankato, was made by my predecessor during the season of 1887, and a report thereon, with maps, rendered January 16, 1888. This report was printed in House Ex. Doc. No. 158, Fiftieth Congress, first session.

By the river and harbor act of August 11, 1888, Congress appropriated for—

Improving Minnesota River, Minnesota, including protecting and holding the banks opposite the borough of Belle Plaine, so as to prevent the river from cutting through the narrow neck of land at that point and thereby changing its channel and course, $10,000.

This is the first appropriation made since 1878 for the improvement of the Minnesota River. Concerning the expenditure of this appropriation my predecessor reported (see page 1804, Annual Report, 1889):

An examination of the river at Belle Plaine, and also from Carver to the mouth of the stream, was made in September, 1888, with a view to obtaining data upon which to base a project for the advantageous expenditure of the sum appropriated by the act of August 11, 1888.

The examination showed that there had not been any marked erosion of the bend at Belle Plaine for several years past; but that to thoroughly protect it against such erosion as might occur from floods or from changes in the channels of the river above the bend would undoubtedly cost more than the entire sum appropriated for the river. It also showed that there had not been any steamboat navigation of the river at that point (an occasional trip by steamboat at high water excepted) for a number of years.

The cost of an adequate open-channel improvement of the river from its mouth to Carver, such an improvement as might last for a number of years, was found to be not less than $52,000.

The appropriation being inadequate for thorough work at either Belle Plaine or the extent of river from its mouth to Carver, and still less adequate for the performance of work if divided between them, it was recommended that the submitting a project for expenditure of the appropriation be delayed until the further wishes of Congress might be known, or until some definite information as to prospective navigation might be obtained upon which to base a project for the best utilization of the appropriation.

Since the submission of the foregoing report it has been represented by reliable parties that a large amount of brick, hay, lime, and wood would be carried by steamboats and barges from points near Shakopee

to St. Paul were navigation made certain throughout the season, and there is an excellent opportunity for a general packet business between the Mississippi River and points on the Lower Minnesota River, which would result in material reduction of freight rates between these points.

In this connection I quote from my predecessor, Maj. Allen (see Annual Report, Chief of Engineers, 1888, page 1574):

From consideration of all the facts that I have been able to collect, I am of the opinion that the Minnesota River from its mouth to Mankato is worthy of improvement.

Total expended under the project following the survey of 1874 to June 30, 1891, including outstanding liabilities, $30,042.

Total expended under all projects, including the survey, to June 30, 1891, inclusive, $117,532.

There are no operations to report for the past year.

Amount expended during the fiscal year ending June 30, 1892, nothing.

The sum of $25,000 can be profitably expended during the fiscal year ending June 30, 1894.

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for year ending December 31, 1891, $299,659.32; value of domestic exports for same period, $452,251.

Abstract of appropriations.

By act approved—		By act approved—	
March 3, 1867	$37,500	March 3, 1875	$10,000
July 11, 1870	10,000	August 14, 1876	10,000
March 3, 1871	10,000	June 18, 1878	10,000
June 10, 1872	10,000	By act of August 11, 1888	10,000
March 3, 1873	10,000		
June 23, 1874	10,000	Total	127,500

Money statement.

July 1, 1891, balance unexpended	$9,967.00
July 1, 1892, balance unexpended	9,967.00
July 1, 1892, outstanding liabilities	9.79
July 1, 1892, balance available	9,957.21
Amount (estimated) required for completion of existing project	693,868.63
Amount that can be profitably expended in fiscal year ending June 30, 1894	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Year.	Steamboats plying on lower part of river.			Freight carried.					
	No.	Tonnage.	Draft.	Wheat.	Hay.	Wood.	Brick.	Miscellaneous.	Total.
		Tons.	Inches.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1888	1								3,350
1889	2	153 180	18 20						4,900
1890	3	117 153 180	18 30 20	62	809	840	1,080	842½	3,633½
1891									

There was no traffic on the river during the season of 1891, as steamboats could not pass the bar at the mouth of the river.

Z 6.

IMPROVEMENT OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA.

The present, which is also the original project for the improvement of this river from Breckenridge to the northern boundary line, adopted in 1877 and amended as to estimate of cost in 1883, consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars.

The estimated cost of this improvement, omitting the item of improvement of Goose Rapids, as based upon the reports of 1874, 1875, and 1877 (see pages 730–732, Report of Chief of Engineers, 1878), was $145,310.18, which estimate as revised, and for the reasons stated in Appendix X 8 of the Annual Report of 1883, was increased to $179,310.18.

The river and harbor act of Congress, approved August 5, 1886, making the money theretofore appropriated for locks and dams at Goose Rapids available for dredging, removal of snags and bowlders, and construction of wing dams, necessarily included in that mode of improving Goose Rapids, which were originally intended to be improved by means of locks. For this reason as well as for others given in the Annual Report of 1887, a new estimate of cost of completing the work became necessary. The cost was placed at $79,598.37. (See Appendix A A to the Annual Report of the Chief of Engineers for 1887, pages 1714, 1715.)

Previous to 1879, when the first bar was dredged through, the ruling depth at ordinary low water between Moorhead and Goose Rapids has been stated to have been but 1½ feet, and below Grand Forks but 2 feet. The dredging work to June 30, 1891, has resulted in a 3-foot channel at ordinary low water, averaging 60 feet in width, from Moorhead to a point 80 miles north, and a 4-foot channel at same stage averaging 70 feet in width, from Grand Forks to a point 62 miles north, by river, have been made by dredging through the bars.

The river is subject to landslides. These slides can never be anticipated, form obstructions when they occur, and have to be removed in whole or in part, thereby increasing the amount of cost of the improvement.

The removal of snags and trees between Moorhead and Abercrombie improved that portion of the stream for navigation during high and medium stages of water.

Expended upon the improvement from commencement of work in 1877 to June 30, 1891, including outstanding liabilities, $198,932.58.

Operations during the fiscal year ending June 30, 1892.—The field work has consisted in dredging and removal of snags, bowlders, and leaning trees, from July 1 to October 28, 1891. During the spring of 1892, the fleet had been repaired and placed in readiness for the resumption of work when a new appropriation became available.

The dredging operations of last fall extended over 52½ miles of river, 30 miles north of to 82½ miles north of Grand Forks. The dredged channels were made the standard width of 60 feet, except some channels dredged during August and September, when very low water prevailed, that were made 55 feet in width, and four bars dredged through at the close of the season have but 35 feet width.

Table of dredging work performed during fiscal year ending June 30, 1892.

	Excavation.	Length of channel made.	New cuttings.	Old cuttings extended, etc.	Wing and training dams.	River worked over.
	Cubic yds.	*Lin. feet.*	*No.*	*No.*	*Lin. feet.*	*Miles.*
Dredge Otter Tail	54,760	12,725	13	3	13,705	44½
Dredge Unser Fritz	45,682	8,785	6	....	9,990	8
Total	100,442	21,510	19	3	23,695	52½

Average cost of the dredging was 11.26 cents per cubic yard.

During July, 1891, the steamer *Ogama*, when it could be spared from the fleet of dredges, removed obstructions from Goose Rapids as follows: Bowlders, 27½ cubic yards, at a cost of $5.37 per cubic yard; overhanging trees and snags, 34, at a cost of $3.26 each.

The total work done on this stream since the first appropriation for its improvement was made in 1876, and extending from Fort Abercrombie to a point 93 miles north of Grand Forks, a total river distance of 321 miles, is as follows:

Cubic yards of material dredged	683,620
Snags removed	635
Overhanging trees removed	8,722
Cubic yards of bowlders removed	409¼
Stumps removed	198
Piles removed	23
Drift piles (collection of driftwood, trees, etc.)	8
Barge removed	1
Total linear feet of channel excavated	126,807
Total linear feet of wing and training dams constructed	169,835

On the portions of the river worked over by the dredges the average depth of the channel has been increased from 1½ to 2 feet.

Mr. Rufus Davenport, assistant engineer upon this improvement for the past ten seasons, has exhibited faithfulness and zeal in carrying out the work intrusted to him.

All of the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1892, including outstanding liabilities, $15,248.02.

This work is in the collection district of Minnesota and North and South Dakota. Collections for year ending December 31, 1891, $336,097.38. Value of domestic exports for same period, $1,319,390.

Abstract of appropriations.

By act approved—	
August 14, 1876	$10,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	20,000.00
March 3, 1881	18,000.00
By act passed August 2, 1882	10,000.00
By act approved July 5, 1884	10,000.00
By act approved August 5, 1886	$46,947.65
By act of August 11, 1888	20,000.00
By act approved September 19, 1890	25,000.00
By act approved July 13, 1892	25,000.00
Total	239,947.65

Money statement.

July 1, 1891, balance unexpended	$19,158.83
June 30, 1892, amount expended during fiscal year	17,091.78
July 1, 1892, balance unexpended	2,067.05
July 1, 1892, outstanding liabilities	1,300.00
July 1, 1892, balance available	767.05
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	25,767.05
Amount (estimated) required for completion of existing project	9,598.37
Amount that can be profitably expended in fiscal year ending June 30, 1894	9,598.37
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

ST. PAUL, MINN., *January 1, 1892.*

MAJOR: The following report on the status of the improvement of the Red River of the North under the present project, dredging channels through the bars, and the removal of overhanging trees, snags, and bowlders, with summary of work so far accomplished and estimate of work remaining to be done to complete the improvement, with probable cost, is respectfully submitted.

The length of the Red River from Breckenridge to Pembina is estimated at 396.7 miles. Of this distance, 370.7 miles, from Fort Abercrombie to Pembina, comes under the project of improvement by dredging. The 26 miles between Breckenridge and Fort Abercrombie it was proposed to improve by the removal of bowlders only, as that section of the river, owing to sand bars and sharp slopes, could only be made navigable at comparatively high stages of water. The improvement proposed excavated channels through the bars 60 feet wide, with a 3-foot low-water depth from Fort Abercrombie to Grand Forks, and channels of the same width, with a 4-foot low-water depth from Grand Forks to Pembina, and the removal of overhanging trees, snags, and bowlders whenever they proved to be an obstruction to navigation.

Until the close of the season of 1882 it was proposed to make all dredged channels north of the Cheyenne River 80 feet wide. As it was, however, found later on that there was not sufficient water at the lowest stages to fill the 80-foot channels, all cuttings since 1882 have been 60 feet wide. The stage of water adopted as the standard was the low-water of 1879, approximately equal to a discharge of 500 cubic feet per second at Fargo and 1,000 cubic feet per second at Grand Forks, the latter below the outlet of Red Lake River.

Of the proposed improvement there has so far been accomplished the dredging of the 3-foot channel 80 miles north from Fargo and 50 miles south from Grand Forks, the latter including about 15 miles of the lower end of Goose Rapids, and the extension of the 4-foot channel 82 miles north from Grand Forks, which latter work, in connection with the partial improvement of the river by dredging of the most important bars to the north, opens a 3-foot low-water channel to Pembina. In improving the channels the dredges have, so far, worked over 227 miles of river, making available an increased low-water depth of from 18 inches to 2 feet.

From overhanging trees, snags, etc., the river has been cleared from Fort Abercrombie to Frog Point, a distance of 192 miles, taking in all of the river in which obstructions were found; from Fargo to Frog Point in 1877 and again in 1882, and from Fort Abercrombie to Fargo in 1879 and 1880.

From bowlders and snags the channels on Goose Rapids were cleared in 1882, 1887, 1888, and 1891. In 1882 the entire length of the rapids, about 25 miles, was worked over. In 1887, 1888, and 1891 the channels on the northern half of the rapids were cleared. Summary of work done to close of season of 1891:

Channel excavation	cubic yards	684,182
Length of channel cuttings	linear feet	127,217
Length of wing and training dams	do	170,190
Overhanging trees removed		8,707
Snags removed		650
Stumps removed		198
Piles removed		23
Drift piles removed (accumulations of driftwood)		8
Sunken barge removed		1
Bowlders removed	cubic yards	426

Cost of work to date, January 1, 1892.

Channel excavation, 684,182 cubic yards	$115,073.34
Overhanging trees, stumps, snags, piles, etc., 9,586	12,783.30
Bowlders, 426 cubic yards	2,101.44
Sunken barge	31.51
Construction of dredging fleet	43,530.42
Repairs	16,375.29
Contingent expenses	20,963.67
Total	210,858.97
Total appropriations	214,947.65
Unexpended	4,088.68
Cost of excavation per cubic yard, including cost of fleet, repairs, and contingent expenses	.2864
Cost of excavation per cubic yard, including cost of operation and maintenance of boats only	.2067
Cost of removal of trees, snags, stumps, etc	1.3334
Cost of removal of bowlders, per cubic yard	4.9329
Per cent of contingent expenses on entire work	.0994

The cost of excavating per cubic yard includes placing the material in the wing and training dams.

The dredging fleet now in the Red River consists of the following boats: Two dredges, *Unser Fritz* and *Otter Tail*; 2 steamboats, *General Poe* and *Ogama*; 2 quarter boats, 1 derrick boat, 2 slide scows, 5 wood barges, 1 storehouse boat, and 6 skiffs. The boats are all in fair condition, requiring only minor repairs to fit them for resumption of work.

WORK REMAINING TO BE DONE TO COMPLETE THE IMPROVEMENT OF THE RED RIVER OF THE NORTH UNDER THE PRESENT PROJECT, WITH ESTIMATED COST.

South of Fargo.—From surveys and examinations made of the river south of Fargo prior to 1882 it was estimated that 40,000 cubic yards of dredging would be required to open a continuous low-water channel to Fort Abercrombie. As, however, the estimates of that time were based upon what was believed to be the mean low-water stage, since proved to be at least 1 foot too high, it is now estimated to require 60,000 cubic yards of dredging.

This section of river is also obstructed by bowlders, snags, and overhanging trees. It was partially cleared of obstructions during the winter of 1879–'80 between Fort Abercrombie and Fargo, but the work was done during a comparatively high-water period and many of the most dangerous obstructions were concealed under the ice. The lower governing stage of water of recent years has also brought into view many obstructions that were then passed over as harmless or overlooked entirely.

The length of the river from Breckenridge to Fargo is 101.57 miles, over which distance the work is distributed as follows: From Breckenridge to Fort Abercrombie, 25.97 miles, bowlders to be removed from channel. This work, it is estimated, will require the services of a land party of twelve men and two teams for five months, at a total cost of $5,000. The work on this section of river can best be done at an extreme low stage of water.

From Fort Abercrombie to Fargo, 75.6 miles, bowlders and snags to be removed from channel and overhanging trees from banks. To clear this section of river from obstructions to navigation it is estimated that the services of a snag boat will be required for five months, at a total cost of $5,000. It is at the lower end of this portion of the river, for the first 6 miles south of Fargo, that the 60,000 cubic yards dredging previously mentioned will be required.

North of Fargo.—To complete the improvement of the river between Fargo and Grand Forks there now remain 20 miles of river to be worked over by the dredges to connect the excavated channels from the north and south, including about 10 miles of the upper end of Goose Rapids; in all estimated at 120,000 cubic yards of channel excavation. It is also estimated that the services of a snag boat will be required for two months on Goose Rapids to clear the channel of snags and bowlders that have accumulated since the last clearing out. (Probably from the action of the ice and land slides.) Estimated cost, $2,000.

Between Grand Forks and Pembina, 143.5 miles, it is estimated that 50,000 cubic yards of dredging will be required to complete the 4-foot channel to Pembina.

On this section of river, near Drayton, there are two bars, averaging about 1,500 linear feet each, estimated as requiring 15,000 cubic yards of channel excavation; and four bars of a total length of 8,500 linear feet, with 35-foot channels to be widened to 60 feet, estimated at 20,000 cubic yards; and between Drayton and Pembina a few short bars or mud lumps, estimated as requiring 6,000 cubic yards of channel excavation.

Summary of estimated cost of work to complete the improvement of the Red River of the North.

Channel obstructions:		
From Breckenridge to Fort Abercrombie, bowlders to be removed		$5,000
From Fort Abercrombie to Fargo, snags, boulders and overhanging trees		5,000
From Goose Rapids, bowlders, snags, etc		2,000
Dredging:		
From Fort Abercrombie to Fargo, cubic yards excavation......	60,000	
From Fargo to Grand Forks, cubic yards excavation...........	120,000	
From Grand Forks to Pembina, cubic yards excavation	50,000	
Total cubic yards excavation, at 20 cents per cubic yard	250,000	46,000
		58,000
For contingent expenses, 10 per cent..............................		5,800
Total		63,800

The above estimate of the cost of the work remaining to be done to complete the improvement of the Red River exceeds the previous estimate $29,201.63. The necessity for the increased estimate of cost has been caused partially by land slides, which have, in places, in recent years, destroyed the natural channels, rendering extra dredging necessary; but mainly by the lower prevailing stages of water. Since the spring of 1886 it is estimated that to produce the 4-foot channels it has required an average of 1 foot deeper cutting than in preceding years, which fact has, of course, rendered it necessary to dredge many bars not included in the original estimates, and probably increased the amount of channel cutting required about 20 per cent.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

REPORT OF MR. R. DAVENPORT, ASSISTANT ENGINEER.

Grand Forks, N. Dak., June 30, 1892.

MAJOR: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1892, is respectfully submitted:

During the last half of the season of 1891, from July 1 to October 28, the work was confined to channel dredging and removal of obstructions in the shape of snags, bowlders, and overhanging trees. The operations of the dredges were in the river north of Grand Forks, extending over some 52½ miles of river, from 30 miles north of Grand Forks to 8 miles north of Drayton. Of the stretch of river worked over, 18 miles had been partially improved in former years, 36 miles had, however, received no previous improvements. In all, 21 channel cuttings were made, of which three cuts were on bars that had been partially improved, the work in 1891 consisting in the widening and extension of the dredged channels and repairs on the wing and training dams.

Total channel excavation, 100,442 cubic yards; length of channel cut through the bars, 21,510 linear feet. With the excavated material, 21,295 linear feet of training dams and 2,400 linear feet of wing dams were constructed.

The average cost of the excavation, including the cost of placing the material in the wing and training dams, was 11.26 cents per cubic yard. Cost of subsistence per ration, 38.7 cents.

As far as possible the channel cuttings were made the standard width and depth, 60 feet wide with a 4-foot depth at low water.

During the extreme low-water stage, in August and September, the cuttings were, however, unavoidably narrowed down to an average width of about 55 feet; and toward the close of the season's work, so that the benefits of the 4-foot low-water channel might be extended as far as possible, four of the bars were run through with one cut of the dredge, making a channel of an average width of about 35 feet.

Surveys, with soundings before and after dredging, were made of the new channels.

The steamer *Ogama*, operated in connection with the dredges, did all the towing and kept the dredges supplied with fuel, subsistence, etc. Number of trips made, 50; total miles run, 2,422. The cost of operating the steamboat in connection with the dredges is included in the cost of the work.

During a short period of fairly high water, in July, the steamer *Ogama* made a

trip to Goose Rapids, and a week was occupied in clearing the channel in the vicinity of Bellemont, N. Dak., of snags, overhanging trees, and bowlders. Length of river worked over, 9 miles; bowlders removed, 57. = 27½ cubic yards; overhanging trees and snags 6 inches to 14 inches in diameter, 34. Cost of removing bowlders, $5.37 per cubic yard; overhanging trees and snags, an average of $3.26 each.

The dredging season of 1891 was brought to a close October 28. After the close of the work all of the boats were returned to winter quarters at Grand Forks, N. Dak.

Dredge work in detail.

DREDGE OTTER TAIL.

No. of cut.	Location.	Excavation.	Training dams.	Wing dams.	Channel cut.
		Cu. yds.	*Lin. feet.*	*Lin. feet.*	*Lin. feet.*
18	Sec. 30, T. 156, R. 50 (new work)	1,488	305	30	305
19	Sec. 30, T. 156, R. 50 (new work)	2,080	300	50	300
20	Sec. 20, T. 156, R. 50 (extension of cut No. 20, 1887)	5,360	970	115	1,020
21	Sec. 18, T. 156, R. 50 (new work)	1,483	500	50	500
22	Sec. 17, T. 156, R. 50 (new work)	6,099	1,220	125	1,260
23	Sec. 7, T. 156, R. 50 (new work)	2,826	600	70	600
24	Sec. 32, T. 157, R. 50 (new work)	8,495	1,535	155	1,565
25	Sec. 32, T. 157, R. 50 (extension of cut No. 22, 1887)	6,640	950	90	950
26	Sec. 32, T. 157, R. 50 (extension of cut No. 22, 1887)	2,419	500		500
27	Sec. 20, T. 157, R. 50 (new work)	655	300		300
28	Sec. 18, T. 157, R. 50 (new work)	1,765	590		590
29	Sec. 18, T. 157, R. 50 (new work)	681	175		175
30	Sec. 17, T. 157, R. 50 (new work)	2,322	325	135	325
31	Sec. 17, T. 157, R. 50 (new work)	911	325	70	325
32	Sec. 6, T. 157, R. 50 (new work, 35-foot channel)	3,483	1,150	90	1,150
33	Sec. 5, T. 158, R. 50 (new work, 35-foot channel)	8,053	2,800	180	2,860
	Total	54,760	12,545	1,160	12,725

The dredge *Otter Tail*, July 1, was at work on cut No. 18, 30 miles north of Grand Forks, and continued the channel excavation until October 28. During this period the dredge worked over 44½ miles of river, making the sixteen channel cuttings as above.

DREDGE UNSER FRITZ.

No. of cut.	Location.	Excavation.	Training dams.	Wing dams.	Channel cut.
		Cu. yds.	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*
2	Sec. 20, T. 159, R. 50 (partial, new work)	4,971	635	270	560
3	Sec. 17, T. 159, R. 50 (new work)	7,328	880	265	880
4	Sec. 18, T. 159, R. 50 (new work)	13,821	2,415	230	2,475
5	Sec. 8, T. 159, R. 50 (35-foot channel, new work)	5,753	1,220	200	1,270
6	Sec. 29, T. 159, R. 50 (new work)	1,523	320	125	320
7	Sec. 32, T. 159, R. 50 (35-foot channel, new work)	12,286	3,280	150	3,280
	Total	45,682	8,750	1,240	8,785

The dredge *Unser Fritz* July 1 was at work in Cut No. 2, on the Pelican bars, which was about two-thirds completed at that time, and continued the channel excavation until the 19th of October.

During this period the dredge worked over 8 miles of river, completing the six channel cuttings as above.

Season of 1892 to June 30.—The work this year was commenced by fitting up the steamer *Ogama* for a trip of inspection over the unimproved portion of Goose Rapids on May 8, taking advantage of the comparatively high stage of water at that time, and after the return to Grand Forks, the preliminary operations necessary to put the dredging fleet in shape were commenced. The work to this date has consisted in the general repair of the boats and machinery, partial calking of the entire fleet, replacing worn-out castings on the dredges, exchange of the boiler of Dredge No. 1 for that of the scow derrick, and everything necessary to prepare the dredging fleet for the resumption of work. Total cost of repairs, distributed generally throughout the fleet, $948.75.

Very respectfully, your obedient servant,

R. DAVENPORT,
Assistant Engineer.

Maj. W. A. JONES,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The stage of water in the Red River during the boating season of the past year has been more favorable than any year since 1885. During the last half of the season of 1891, the water reached the vicinity of zero on the Grand Forks gauge only for a short time during the months of August and September. In 1892, to June 30, the water ranged from 8 feet to 28 feet on the Grand Forks gauge, giving at the lowest 12 feet in the channel to the north of that place and not less than 4 feet on Goose Rapids.

The Red River Transportation Company has been the only steamboat line in active operation during the past year. Their one steamer, the *W. H. Alsop* (157 tons), and a fleet of barges have been steadily occupied.

The following is a statement of the freight moved in 1891.

	Tons.
From the north to Grand Forks, North Dakota:	
Wheat	7,487
From the south to Grand Forks, North Dakota:	
Wheat	3,193
From Grand Forks north:	
Merchandise	60
Lumber	647
Cordwood	750
Total	12,137

Comparative statement of freight moved by steamboats and barges during the past thirteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1891	12,137	1886	10,507	1881	26,557
1890	1,710	1885	23,043	1880	21,651
1889	3,866	1884	29,046	1879	17,829
1888	12,140	1883	25,314		
1887	10,405	1882	31,652		

Z 7.

SURVEYS FOR RESERVOIRS AT THE SOURCES OF MISSISSIPPI, ST. CROIX, CHIPPEWA, AND WISCONSIN RIVERS.

Nothing was done under this head during the past fiscal year, no funds having been available for such work. For account in detail of these surveys reference is made to pages 1507 and 1508, Appendix Y, Part II, Annual Report of Chief of Engineers, 1886.

Money statement.

Amount (estimated) required for completion of existing project............$50,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Z 8.

GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

The Board of Engineers, to whom was referred the project for the application of $37,000, appropriated by the river and harbor act of August 5, 1886, for reservoirs at the headwaters of the Mississippi River, recommended in their report, dated May 24, 1887: "That such gaugings be made at or near St. Paul, during the annual operation of the reservoirs as shall determine accurately the discharge at that point at critical periods." (Page 1692, Annual Report Chief of Engineers, 1887.)

The river and harbor act of August 11, 1888, authorized the gaugings and provided for them as follows:

And the Secretary of War shall cause such gaugings to be made at or near St.

Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of the same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

* * * * * * * *

SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the 21st of February, 1871, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of said expenses shall accompany the annual report of the Chief of Engineers.

Gaugings were not made until the fall of 1889, although an allotment of $900 for the fiscal year ending June 30, 1889, had been made. On account of the lateness in the season and the condition of the river it was not deemed advisable to expend any of the money that year.

The allotments of $600, $900, and $900, made for the fiscal years 1889–'90, 1890–'91, and 1891–'92, respectively, were applied to gauging the Mississippi River at St. Paul.

During the past year a total of 135 gaugings have been made, as follows:

Table of gaugings made at St. Paul, Minnesota, during the fiscal year ending June 30, 1892.

No.	Date.	Place.	Method.	Reading of signal service gauge, St. Paul, Minn.	Discharge in cubic feet per second.	Remarks.
	1891.					
1	July 1	Mississippi River at Robert Street Bridge, St. Paul.	Ellis current meter, No. 21.	2.78	5,773.27	
2	July 2	...do	...do	2.89	5,866.25	Wind downstream.
3	July 3	...do	...do	2.70	5,663.15	
4	July 6	...do	...do	2.10	4,857.89	Wind upstream; rain.
5	July 10	...do	...do	2.54	5,420.16	
6	July 11	...do	...do	2.46	5,162.51	
7	July 13	...do	...do	2.75	5,690.07	Strong wind downstream.
8	July 14	...do	...do	2.46	5,373.48	Rain.
9	July 15	...do	...do	2.27	5,046.35	
10	July 16	...do	...do	2.01	4,821.09	
11	July 17	...do	...do	1.96	4,662.35	
12	July 18	...do	...do	1.90	4,574.56	
13	July 20	...do	...do	1.94	4,948.04	
14	July 21	...do	...do	2.01	4,696.38	
15	July 22	...do	...do	1.91	4,596.75	Strong wind downstream.
16	July 23	...do	...do	1.96	4,637.77	
17	July 24	...do	...do	2.00	4,731.68	
18	July 25	...do	...do	2.00	4,675.77	
19	July 27	...do	...do	1.97	4,516.15	
20	July 28	...do	...do	2.11	4,860.72	Rain.
21	July 29	...do	...do	2.01	4,786.67	
22	July 30	...do	...do	2.09	4,808.89	
23	July 31	...do	...do	2.30	5,259.40	
24	Aug. 1	...do	...do	2.09	4,843.49	
25	Aug. 3	...do	...do	1.80	4,473.76	
26	Aug. 4	...do	...do	1.99	4,566.43	
27	Aug. 5	...do	...do	1.80	4,399.84	
28	Aug. 6	...do	...do	1.80	4,363.60	
29	Aug. 7	...do	...do	1.84	4,390.58	
30	Aug. 8	...do	...do	1.92	4,472.47	
31	Aug. 10	...do	...do	1.96	4,659.21	
32	Aug. 11	...do	...do	1.71	4,136.35	
33	Aug. 12	...do	...do	1.49	3,760.23	
34	Aug. 13	...do	...do	1.47	3,626.33	
35	Aug. 14	...do	...do	1.26	3,507.55	
36	Aug. 15	...do	...do	1.54	3,908.40	
37	Aug. 17	...do	...do	1.51	3,961.19	
38	Aug. 18	...do	...do	1.63	3,963.01	
39	Aug. 19	...do	...do	1.30	3,548.14	
40	Aug. 20	...do	...do	1.86	4,200.84	
41	Aug. 21	...do	...do	1.68	4,109.58	Light rain.

Table of gaugings made at St. Paul, Minnesota, etc.—Continued.

No.	Date.	Place.	Method.	Reading of signal service gauge, St. Paul, Minn.	Discharge in cubic feet per second.	Remarks.
	1891					
42	Aug. 22	Mississippi River at Robert Street Bridge, St. Paul.	Ellis current meter, No. 21.	1.50	3,738.54	
43	Aug. 24	...do	...do	1.36	3,674.88	
44	Aug. 25	...do	...do	1.61	3,892.53	
45	Aug. 26	...do	...do	1.46	3,764.19	
46	Aug. 27	...do	...do	1.46	3,746.77	
47	Aug. 28	...do	...do	1.34	3,532.92	
48	Aug. 29	...do	...do	1.25	3,366.80	
49	Aug. 31	...do	...do	1.48	3,665.06	
50	Sept. 1	...do	...do	1.49	3,792.81	Wind downstream.
51	Sept. 2	...do	...do	1.47	3,636.44	Strong downstream wind.
52	Sept. 3	...do	...do	1.35	3,555.24	
53	Sept. 4	...do	...do	1.31	3,476.63	
54	Sept. 5	...do	...do	1.29	3,390.22	
55	Sept. 7	...do	...do	1.70	4,323.20	
56	Sept. 8	...do	...do	1.49	3,626.98	
57	Sept. 9	...do	...do	1.25	3,208.58	
58	Sept. 10	...do	...do	1.20	3,328.44	
59	Sept. 11	...do	...do	1.40	3,482.96	
60	Sept. 12	...do	...do	1.07	3,233.58	
61	Sept. 14	...do	...do	1.55	4,227.92	Strong wind downstream; large waves.
62	Sept. 15	...do	...do	1.34	3,614.30	
63	Sept. 17	...do	...do	1.40	3,767.84	Very strong wind downstream.
64	Sept. 18	...do	...do	1.34	3,512.16	
65	Sept. 19	...do	...do	1.23	3,327.51	
66	Sept. 21	...do	...do	1.15	3,244.63	
67	Sept. 22	...do	...do	1.38	3,538.58	
68	Sept. 23	...do	...do	1.07	3,111.75	
69	Sept. 24	...do	...do	1.31	3,386.15	
70	Sept. 25	...do	...do	1.28	3,287.82	
71	Sept. 26	...do	...do	1.24	3,428.81	
72	Sept. 28	...do	...do	1.50	3,679.28	
73	Sept. 29	...do	...do	1.62	3,956.24	
74	Sept. 30	...do	...do	1.60	3,893.81	Wind upstream.
75	Oct. 1	...do	...do	1.56	3,875.35	Rain.
76	Oct. 2	...do	...do	1.70	3,981.58	Strong wind downstream.
77	Oct. 3	...do	...do	1.85	4,210.55	
78	Oct. 5	...do	...do	1.63	3,999.09	
79	Oct. 6	...do	...do	1.80	4,242.02	
80	Oct. 7	...do	...do	1.45	3,606.50	
81	Oct. 8	...do	...do	1.60	3,963.94	
82	Oct. 10	...do	...do	1.50	3,824.29	
83	Oct. 12	...do	...do	1.35	3,537.39	
84	Oct. 13	...do	...do	1.50	3,808.86	
85	Oct. 14	...do	...do	1.45	3,720.91	
86	Oct. 15	...do	...do	1.45	3,761.12	
87	Oct. 16	...do	...do	1.40	3,648.76	
88	Oct. 17	...do	...do	1.27	3,458.31	
89	Oct. 19	...do	...do	1.40	3,710.14	
90	Oct. 20	...do	...do	1.50	3,830.91	
91	Oct. 21	...do	...do	1.48	3,894.75	
92	Oct. 22	...do	...do	1.48	3,780.80	
93	Oct. 23	...do	...do	1.32	3,543.49	
94	Oct. 24	...do	...do	1.21	3,539.56	
95	Oct. 26	...do	...do	1.18	3,459.02	
96	Oct. 27	...do	...do	1.46	3,692.73	
97	Oct. 28	...do	...do	1.35	3,535.92	
98	Oct. 29	...do	...do	1.41	3,658.90	
99	Oct. 30	...do	...do	1.38	3,590.47	Wind downstream.
100	Oct. 31	...do	...do	1.32	3,612.36	Strong wind downstream. Very cold and high waves.
101	Nov. 3	...do	...do	1.38	3,578.93	
102	Nov. 4	...do	...do	1.10	3,192.95	
103	Nov. 5	...do	...do	1.31	3,446.98	
104	Nov. 6	...do	...do	1.11	3,189.88	
105	Nov. 7	...do	...do	0.97	3,036.18	
106	Nov. 9	...do	...do	0.82	2,686.20	
107	Nov. 10	...do	...do	1.00	2,988.85	
108	Nov. 11	...do	...do	0.54	2,422.52	
109	Nov. 12	...do	...do	0.90	2,824.35	
110	Nov. 13	...do	...do	0.65	2,507.87	
111	Nov. 14	...do	...do	0.80	2,742.97	
	1892					
112	June 1	...do	...do	11.45	39,478.47	
113	June 2	...do	...do	11.10	38,093.46	
114	June 3	...do	...do	10.80	35,547.75	
115	June 4	...do	...do	10.46	33,525.12	

Table of gaugings made at St. Paul, Minnesota, etc.—Continued.

No.	Date.	Place.	Method.	Reading of signal service gauge, St. Paul, Minn.	Discharge in cubic feet per second.	Remarks.
	1892.					
116	June 6	Mississippi River at Robert Street Bridge, St. Paul.	Ellis current meter, No. 21.	....	29,303.94	
117	June 7	...do	...do	9.65	31,149.52	
118	June 8	...do	...do	9.50	28,936.73	
119	June 9	...do	...do	9.25	28,082.76	
120	June 11	...do	...do	8.97	26,085.24	
121	June 13	...do	...do	8.70	24,473.48	
122	June 14	...do	...do	8.70	24,768.81	
123	June 15	...do	...do	8.80	25,798.53	
124	June 16	...do	...do	8.95	26,273.18	
125	June 17	...do	...do	9.50	28,982.61	
126	June 18	...do	...do	9.52	29,074.36	
127	June 20	...do	...do	9.85	31,182.68	
128	June 21	...do	...do	9.80	30,150.63	
129	June 22	...do	...do	9.65	29,473.57	
130	June 23	...do	...do	9.48	28,458.74	
131	June 24	...do	...do	9.00	26,242.52	
132	June 25	...do	...do	8.75	24,899.49	
133	June 27	...do	...do	8.65	24,945.28	
134	June 28	...do	...do	8.80	25,725.16	
135	June 30	...do	...do	8.60	24,128.47	

The gaugings were made by observing the mid-depth velocities in sections 20 feet apart. Mean velocity was taken as 95 per cent of mid-depth velocity.

The results of the gaugings are interesting and valuable so far as they go, but the money heretofore allotted and made available for gaugings has been inadequate to procure the information needed for a correct and scientific investigation of the effect of the reservoir water on the Mississippi River. It is imperative that this effect shall be ascertained and established beyond question. The knowledge gained would be of use, not only in connection with the present reservoir system at the head waters of the Mississippi River, but also in determining the value of reservoirs as a means of improving rivers in general.

It is recommended that Congress be asked to fix the amount to be annually available for this specific work.

Amount expended during the fiscal year ending June 30, 1892, including outstanding liabilities, $900.

Abstract of allotments.

For fiscal year ending June 30 –

1889	*$900
1890	600
1891	900
1892	900

Money statement.

July 1, 1891, balance unexpended	$1,179.07
June 30, 1892, amount expended during fiscal year	1,133.85
July 1, 1892, balance unexpended	45.22
July 1, 1892, outstanding liabilities	45.22
Amount allotted for fiscal year ending June 30, 1893	500.00
Amount that can be profitably expended in fiscal year ending June 30, 1894 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,600.00

* Not used.

Itemized statement of expenditures during the fiscal year ending June 30, 1892.

Date.	To whom paid.	For what paid.	Amount.
1891.			
July 31	Sundry persons	Pay roll for July, 1891	$155.00
Aug. 29	St. Paul White Lead and Oil Co	Paint	1.15
Sept. 2	Sundry persons	Pay roll for August, 1891	189.25
Sept. 16	John Wolf	Services	.75
Sept. 22	A. O. Powell	Traveling expenses	1.92
	D. W. Collies	do	1.22
	George W. Allen	do	1.82
Oct. 1	Sundry persons	Pay roll for September, 1891	133.50
Oct. 16	Robinson and Cary Co	Wire rope, etc	7.80
	Ames, Ebert & Co	Dry batteries	3.00
	American Express Co	Express charges	.45
Nov. 2 and 11	Sundry persons	Pay roll for October, 1891	171.17
Dec. 1	do	Pay roll for November, 1891	153.67
1892.			
Feb. 5	Henry E. Wedelsteadt & Co	Stationery	51.39
	Wright, Barrett & Stilwell	Waste baskets	2.17
	Keuffel, Esser & Co	Blue-print paper	1.15
	Boeringer & Son	Section liner	7.50
	Pioneer Press Co	Mounting maps	3.50
	Brown, Treacy & Co	Paper and ink	1.75
	Noyes Bros. & Cutler	Chemicals, etc	4.62
	Ames, Ebert & Co	Okonite	1.50
June 8	D. W. Collies	Services	10.50
	Total		854.78

Outstanding liabilities June 30, 1892.

To whom owing.	On account of—	Amount.
D. W. Collies	Services	$35.00
St. Paul Brass Works	Meter weight	9.36
Robinson and Cary Co	Wire sash cord	.40
Boeringer & Son	Brass tags	.46
		45.22
Expended during the fiscal year ending June 30, 1892		854.78
Total		900.00

Z 9.

PRELIMINARY EXAMINATION AND SURVEY OF RED RIVER OF THE NORTH AND TRIBUTARIES ABOVE FERGUS FALLS AND CROOKSTON, MINNESOTA, AND OF BIG STONE LAKE, MINNESOTA, AND SOUTH DAKOTA, WITH A VIEW TO IMPROVING NAVIGATION THEREON BY THE ERECTION OF SUITABLE DAMS, OR BY SUCH OTHER MEANS AS MAY BE DEEMED BEST.

[Printed in House Ex. Doc. No. 127, Fifty-second Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 6, 1892.

SIR: I have the honor to submit herewith reports, dated February 24, 1891, and January 11, 1892, respectively, upon preliminary examination and survey, with map,* of Red River of the North and tributaries above Fergus Falls and Crookston, Minn., and of Big Stone Lake, Minnesota and South Dakota, with a view to improving navigation

*Not reprinted. Printed in House Ex. Doc. No. 127, Fifty-second Congress, first session.

thereon by the erection of suitable dams or by such other means as may be deemed best, made by Maj. W. A. Jones, Corps of Engineers, in compliance with provisions of river and harbor act approved September 19, 1890.

The plan of improvement presented contemplates the formation of two reservoir systems, at Red Lake and Lake Traverse, at the head waters of tributaries to the Red River of the North, for the purpose of diminishing the effects of floods and of storing water for use at low stages in the Red River system.

The plan for the Red Lake reservoir system contemplates the construction of a reservoir dam, with a lock, in Red Lake River near the outlet of the lake. Navigation up Red Lake River to the lake is to be provided for by the construction of locks and dams at Crookston and Thief River.

The plan for the Lake Traverse reservoir system contemplates the diversion of Otter Tail River into Rabbit and Bois de Sioux rivers by constructing a dam and canal near Breckenridge; construction of a dam and lock in Bois de Sioux River below the mouth of the Rabbit; and construction of a dam at the foot of Big Stone Lake, and excavation of a canal to connect Big Stone Lake with Lake Traverse.

The estimated cost of these works, not including flowage damages, is as follows:

Red Lake system:		
Red Lake dam and lock	$150,000	
Dam and lock near Thief River	150,000	
		$300,000
Lake Traverse system:		
Dam and lock in Bois de Sioux River below Rabbit River	150,000	
Canal between Otter Tail River and Rabbit River, near Breckenridge	60,000	
Dam across Otter Tail River	20,000	
Dam at foot of Big Stone Lake	150,000	
Canal between Big Stone Lake and Lake Traverse	30,000	
		410,000
Surveys and contingencies		150,000
Total		860,000

Major Jones also suggests that a canal 55 miles long could be constructed from Red Lake to Rainy Lake River (which empties into the Lake of the Woods), extending navigation to that region, at a cost of about $15,000 per mile.

The amount of commerce on the Red River of the North does not justify undertaking a project of this magnitude, and in my opinion the river is not worthy of improvement to this extent by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. S. B. ELKINS,
Secretary of War.

PRELIMINARY EXAMINATION OF RED RIVER OF THE NORTH AND TRIBUTARIES ABOVE FERGUS FALLS AND CROOKSTON, MINNESOTA, AND OF BIG STONE LAKE, MINNESOTA AND SOUTH DAKOTA, WITH A VIEW TO IMPROVING NAVIGATION THEREON BY THE ERECTION OF SUITABLE DAMS, OR BY SUCH OTHER MEANS AS MAY BE DEEMED BEST.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 24, 1891.

GENERAL: In compliance with the act of Congress, September 19, 1890, I have the honor to report the result of a preliminary examination of "Red River and tributaries above Fergus Falls and Crookston and of Big Stone Lake, with a view to improving navigation thereon by the erection of suitable dams, or by such other means as may be deemed best, together with an estimate of cost."

I interpret the foregoing as calling for an investigation of the question of improving the Red River of the North by means of reservoirs at Big Stone Lake, and on the Otter Tail and Red Lake rivers, and have made the examination accordingly.

DESCRIPTION OF THE RED RIVER OF THE NORTH, WITH TRIBUTARIES, AND BIG STONE LAKE AND LAKE TRAVERSE.

RED RIVER OF THE NORTH.

The Red River of the North is a sluggish, narrow, and tortuous stream subject to excessive variations in volume. It drains an area of 32,000 square miles of fertile country in the States of Minnesota and North Dakota. Together with one of the tributaries, the Bois de Sioux, it forms the boundary line between those States.

The region drained in Minnesota lies west of the Mississippi River basin and north of the Minnesota; in North Dakota, east of the Devils Lake basin and the James, or Dakota, River.

The main river is formed at Breckenridge by the conjunction of the Bois de Sioux and Otter Tail River.* Its general course, as well as that of the Bois de Sioux, is due north to the British Possessions and empties into Hudson Bay. It has no connection with any other waters of the United States, except during times of freshets, when the waters of Lake Traverse, the source of the Bois de Sioux, mingle with those of Big Stone Lake on the Minnesota River.

On inspecting a map of the Red River Basin, one is struck with the fact that most of the tributary streams have their sources in a higher latitude than their mouths. This peculiarity extends as far north as the Saskatchewan, in Manitoba, and would seem to suggest that originally the general slope of the country was to the south, and that the waters of this immense area were drained by a large stream which occupied the now comparatively dry valley of the Minnesota. Maj. G. K. Warren, in his report on the Minnesota Valley, advances the theory that there has been a subsidence along the valley of the Red River, having its maximum below Lake Winnipeg, together with a possible upheaval of the headwaters of the Minnesota River. All the natural features of the Red River Valley confirm this theory. (Col. Farquhar's report, page 370, Annual Report, 1875, Part I.)

The tributaries from the west, or Dakota, are inconsequent, except during periods of freshets, though a few, like the Cheyenne, are of great length.

The topography of the country (prairie) through which the Dakota tributaries flow is not adapted to the sustenance of rivers. There are

*Authorities differ as to whether the Otter Tail River extends beyond Otter Tail Lake, with that Lake as the head of the Red River of the North. This office has always applied the names as used in the text.

no forests, swamps, nor lakes to form natural reservoirs. Those from the east, or Minnesota, present many like characteristics, with the exception of the Otter Tail and Red Lake rivers, which take their rise in the timbered country and are fed, in the former, by a system of lakes, and in the latter by one large lake. These two streams furnish about all of the low-water volume of the river.

The Bois de Sioux, one of the two streams forming the Red River of the North and the most southern tributary, is, in its natural state, of little importance, but becomes of some prominence approaching the Otter Tail and Red Lake rivers, from the fact that it takes its rise in Lake Traverse, which perhaps might be developed into an artificial reservoir for the increase of the low-water volume of the Red River.

The banks of Red River are of clay; in height they increase from 12 feet at Breckenridge to 50 feet at Pembina.

The bed of the river is mainly of clay, with some gravel and bowlders below Breckenridge and at Goose Rapids.

For a short distance below the mouth of the Red Lake River sand that has been carried down by that stream is found mixed with the clay in the bars, but it soon disappears.

The slope of the river is small and tolerably uniform. The total fall from Breckenridge to the northern boundary line, a distance by river of 395.52 miles, is 194.52 feet, or at the rate of 0.49 foot per mile. The maximum slope occurs at Goose Rapids, where the river flows through a drift formation 12 miles wide, extending across the country at right angles to the course of the river. The rapids are produced by bars of tenacious clay covered with a layer of coarse gravel, cobblestones, and bowlders. The maximum fall is at the head of the rapids, being 4.6 feet in 0.928 mile.

Until 1886 the lowest volume at Moorhead was considered to be about 500 cubic feet per second. In 1874 the low-water volume at Breckenridge was placed as high as 1,000 cubic feet per second, based "on information obtained that covers the last twenty years [1854–'74]." Since 1886 the low-water volume has been reduced one-half. During excessive dry periods the Bois de Sioux is merely pools of water separated by dry bars. The Otter Tail River furnishes the supply of water at Breckenridge, about 200 cubic feet per second. Between that point and Moorhead this amount is increased, by the tributaries, 50 cubic feet per second, making 250 cubic feet per second, the low-water volume at Moorhead. Before reaching the Red Lake River another increment of 50 cubic feet per second is added. The latter stream joins the Red River at Grand Forks and furnishes about 200 cubic feet per second at extreme low water. The volume of the Red River of the North at Grand Forks is therefore 500 cubic feet per second. From here to the boundary line probably 100 cubic feet per second is added.

The ruling depths in the river for the extreme low stage of 250 cubic feet per second at Moorhead are approximately as follows:

	Inches.
Breckenridge to Moorhead	6
Moorhead to Goose Rapids	12
Goose Rapids	6
Goose Rapids to boundary line	12

For the stage corresponding to 500 cubic feet per second at Moorhead, the ruling depths on the undredged bars are:

	Inches.
Breckenridge to Moorhead	12
Moorhead to Goose Rapids	18
Goose Rapids	18
Goose Rapids to boundary line	18

The following table shows the length, width, depth, high and low water volumes, height of banks, and flood level:

From—	To—	Distance in miles. By river.	Distance in miles. By land.	Slope. Total fall.	Slope. Average per mile.
				Feet.	*Feet.*
Breckenridge	Fort Abercrombie	26.00	......	35.5	1.36
Fort Abercrombie	Moorhead	71.00	......	38.2	
Moorhead	Goose Rapids	98.06	......	50.658	.516
Goose Rapids	Frog Point	21.96	......	21.169	
Frog Point	Grand Forks	35.00	22	12.8	.365
Grand Forks	Turtle River	25.00	18	6.2	.403
Turtle River	Big Salt River	30.50	13	20.661	.298
Big Salt River	Lower End Pelican bars	40.00	17		
Pelican	Boundary line	48.00	28	9.333	.194
Total		395.52	......	194.521	....

From—	To—	Slope. Maximum. At—	Slope. Maximum. Length.	Slope. Maximum. Fall.	Slope. Maximum. Average per mile.	Width of river.
			Miles.	*Feet.*	*Feet.*	*Feet.*
Breckenridge	Fort Abercrombie.	Conollys Rapids			2.446	125
Fort Abercrombie	Moorhead				1.389	95
Moorhead	Goose Rapids					100
Goose Rapids	Frog Point	Upper End of Goose Rapids.	0.928	4.6	4.95	160
Frog Point	Grand Forks					100–200
Grand Forks	Turtle River	Turtle River bars	5.000			
Turtle River	Big Salt River					250–300
Big Salt River	Lower End Pelican bars.					
Pelican	Boundary line					

From—	To—	Height of banks.	Low-water volume.	High-water volume.	Range between high and low water mark.
Breckenridge	Fort Abercrombie.	12 feet	At Breckenridge, 200 cubic feet per second.		At Breckenridge, 16 feet.
Fort Abercrombie	Moorhead	At Moorhead, 37½ feet.	At Moorhead. 250 cubic feet per second.	At Moorhead, 20,000 cubic feet per second.	At Moorhead, 32.8 feet.
Moorhead	Goose Rapids			At Elm River, 30,000 cubic feet per second.	At Elm River, 36.2 feet. At Caledonia, 39.6 feet.
Goose Rapids	Frog Point	At Frog Point, 61⅓ feet.			
Frog Point	Grand Forks		At Grand Forks, 500 cubic feet per second.		At Grand Forks, 42.5 feet.
Pelican	Boundary line	At Pembina, 50 feet.	At boundary line, 600 cubic feet per second.	At Pembina, 40,000 to 50,000 cubic feet per second.	At Pembina, 38.5 feet.

The obstructions to navigation are:

(1) Lack of water during low-water stages. When the volume falls to 250 cubic feet per second at Moorhead navigation is practically suspended and can not be made possible within a reasonable cost without an increment to the volume.

(2) With a volume of 500 cubic feet per second at Moorhead the obstructions between Breckenridge and Moorhead have been stated in Maj. Allen's report dated January 31, 1880 (page 1829, Annual Report 1881, Part II), as follows:

From Breckenridge (the junction of the Otter Tail and Bois de Sioux rivers) to old Fort Abercrombie—a distance by river of 26 miles—the slope or fall of the surface of the stream is 35.542 feet, or an average slope per mile of 1.36 feet, with one stretch included of 1.3 miles with an average slope of 2.86 feet per mile. This latter slope is over what is known as Conollys Rapids. The river for the entire 26 miles is about 200 feet wide, and for a greater portion of the distance the river bed is formed of gravel, mixed with frequent bowlders, some of which have cubical contents of 5 yards. Soundings show, in eleven different stretches of river, a low-water channel of less than 1 foot. These are not isolated soundings, but continue for distances of from 1 to 500 feet, and even for these depths of channel are very narrow and tortuous and completely hemmed in by large bowlders. * * * Fort Abercrombie should be considered the head of navigation on the Red River of the North, the portion of river between that point and Breckenridge being possible for navigation for a few days only in the year, during the period of extreme high water.

From Fort Abercrombie to Fargo [opposite Moorhead] the distance, by river, is 75.6 miles, with an average slope per mile of a little over 0.5 of a foot. During the winter of 1879 and 1880 a party cut down the overhanging trees and removed all snags which were to be found while the river was frozen. The work was well done as far as it was possible to do, but during the period of open river and low water a considerable number of dangerous snags are still to be seen, and should be removed. * * *

The river from Fort Abercrombie to Fargo is naturally superior for navigable purposes to that part of the stream from Fargo to the mouth of the Cheyenne River 20 miles below Fargo, and very little work will be required to perfect it. To within 6 miles of Fargo nothing is required but the removal of snags; but over the latter 6 miles mentioned about 40,000 yards of earth will have to be removed by dredging. The removal of snags is by far the more needed improvement at present, and should, if possible, be accomplished first.

Below Moorhead the obstructions are clay bars, on which dredging operations have been carried on since 1879. These bars, as a rule, are formed in a peculiar manner, owing to the geological formation of the country.

In 1879 the assistant engineer, in local charge of the dredging work, thus speaks of them:

It is a curious fact that in nearly every case, in the upper river, the deep water or channel is on or near the points, and the bars and shoals are located in the bends; or, in other words, the channel is on the convex side of the river and the shoals in the concave. * * *

The cutting or undermining of these steep banks produces hard clay bars and lumps, which generally extend over half way across the river. These bars are so frequent and the water so shallow over them, that they cause a profile of the river to show a series of level pools, connected by short pieces of much greater slope and consequent swifter currents. These pools have generally sufficient depth of water for navigation purposes. (Pages 1192–3, 1879 Annual Report, Part II.)

Under date of June 30, 1887, Assistant Engineer R. Davenport reported, in relation to them: * * *

A number of extensive land slides have come into the river during the last two years. * * *

The banks of the Red River are always moving on the bend side, discharging large quantities of clay and earth into the river, but during the last two years the slides have been more extensive and more numerous than ever before noticed, at least since the work of improvement was commenced. Two years ago, in 1885, a slide occurred 5 miles north of Moorhead, which must have brought into the river at least 100,000 cubic yards of clay and earth. And last spring, 1886, on the rapids, a slide containing probably 200,000 cubic yards completely filled the river, forming for a time a sharp fall of 5 feet or more. The river in a few months formed a narrow and crooked channel through the obstructions, but when the dredge passed over that portion of the river this spring it was found necessary to excavate 3,000 cubic yards of material from the channel at that point to permit the passage of steamboats (the river at that place was formerly 200 feet wide), and for ten miles below the slide it was found that new bars had been formed, which will all have to be dredged, in what was formerly considered fairly good river.

In addition to the extensive slides above mentioned, numerous smaller slides have also occurred, both on the improved and unimproved portions of the river. In some localities below Grand Forks they have entirely changed the shape of the bottom of the river. Two new cuts made this spring, No. 9 A and No. 9 B, requiring the excavation of 5,200 cubic yards, were rendered necessary from this cause alone, and a number of other places have been found where digging must soon be done from the same cause.

As previously mentioned, the banks of the Red River are always in motion to an extent, though why the slides should have been more numerous during the past two years is not known. (Pages 1720–21, Part II, Annual Report, 1887.)

Below Moorhead the bars are most numerous between that place and Frog Point, including Goose Rapids, which presents the most serious obstruction.

Below Frog Point the obstructions are reported on pages 1587–88, Part II, Annual Report, 1880.

1. *From Frog Point to Grand Forks, Dakota.*— * * * This section of the river is by far the best portion that is situated within the limits of the United States. * * * The obstruction in this section of the river consists of 13 snags, 4 overhanging trees, and 1 gravel bar, which would be easily removed by dredging. * * *

2. *From Grand Forks to the mouth of the Turtle River.*— * * * The condition of the river from Grand Forks to the Turtle River bars (a distance of 11 miles) is good, with no low-water soundings of less than 4 feet. The Turtle River bars extend for a distance of 5 miles and can only be removed by dredging. * * * From the foot of these bars to the Turtle River, a distance of 9 miles, the character of the river is improved, only two bars of any length being found. * * *

3. *From the mouth of Turtle River to the mouth of Big Salt River.*— * * * Through this section of the river more shallow water is found than in any other, with the exception of Turtle River and Pelican bars. The bottom is very uneven, and the transitions from 10 to 2¼ feet soundings are very abrupt and numerous. None of the bars are long, but few extending for a greater distance than 500 feet. * * *

4. *From the mouth of the Big Salt River to the lower end of the Pelican bars.*— * * * The first 24 miles of river below the Big Salt are in fair condition, and but little dredging would be required to give a continuous 4-foot depth of channel. The succeeding 16 miles will require more dredging to obtain a 4-foot channel than any other portion of the lower river. There is one section of 5 miles that would require continuous dredging to furnish a greater low-water depth than 30 inches.

5. *From Pelican bars to the boundary line.*—The river between these points is in good navigable condition, free from snags and bars, and is being constantly traversed by steamboats.

THE RED LAKE RIVER.

The Red Lake River is the principal tributary of the Red River of the North, which it joins opposite Grand Forks, N. Dak. The river lies wholly in the State of Minnesota and takes its rise in Red Lake, the largest body of water within the State. The river is quite crooked, being 325 miles in length by water from Red Lake to the mouth, while the length of its valley is about 125 miles. The volume of the river at its mouth varies from about 200 cubic feet per second during extreme low water periods to a flood discharge of 15,000 cubic feet per second.

Red Lake has an area of 500 square miles; the drainage basin, exclusive of the lake, is estimated at 1,200 square miles. Major C. J. Allen, under date of December 1, 1886, reported—

Red Lake could probably be converted into a reservoir and * * * would probably form a valuable adjunct to the improvement of the Red River of the North from Grand Forks to the northern boundary line.

The Red Lake River from Red Lake to the Thief River is sluggish, 2 feet deep at low water, and about 200 feet in width. The range, in height, between high and low water stages at the mouth of the Thief River is about 4 feet.

From the Thief River to Fishers Landing, 160 miles, the slope is about 3 feet per mile. The channel is obstructed by bowlders and frequent rapids. This reach is wholly unnavigable and can not be im-

proved except by locks and dams. There are two dams for water power purposes within this stretch—one of 15 feet head at Red Lake Falls, and the other of 10 feet head at Crookston. The range between high and low water stages at Crookston is about 15 feet.

From Fishers Landing to the Red River of the North, 40 miles, the river again becomes sluggish, with a low-water depth of about 2 feet and 150 feet in width. When Fishers Landing was the terminus of the railroad this reach of the river was navigated by the Red River steamboats, but in late years and since the construction of railroads in the district there has been no commerce on the river. In 1884 an iron highway bridge was built, without a draw, over the river near its mouth, which practically shuts steamboats out, even if they desired to navigate the river, except possibly during very low water.

THE OTTER TAIL RIVER.

The Otter Tail River, the second tributary in size and volume to the Red River of the North, connects with the Bois de Sioux at Breckenridge, Minn., and there forms the Red River.

It is a Minnesota stream and takes its rise in the system of lakes in the timbered and flat country west of the Mississippi. The low-water discharge is about 200 cubic feet per second. It might be considered the most important tributary to the Red River, for without it the latter, above Grand Forks and during low-water periods, would be an exceedingly small stream.

There is no data or record relating to the Otter Tail River above Fergus Falls except such as may be gathered from an inspection of a State sectional map.

An examination of the river, below Fergus Falls, was made in 1886.

For about 10 miles below Fergus Falls the Otter Tail River is full of bowlders; the descent is sharp, and a number of small rapids occur. In the next 10 miles the slope reduces, although the current is rapid, and the bed of the stream is obstructed by large quantities of bowlders. During high-water stages small flatboats with light loads have run down this 10-mile section, but at great risk. The remainder of the river to Breckenridge, about 50 miles in distance, is comparatively sluggish, with depth of about 3 feet, and average width of 70 feet at ordinarily low-water stage. [During extreme low water the depth would be considerably less.] In former years steamboats of fair size have navigated this section of the stream during high stages of water, and numbers of flatboats laden with flour, coal, lumber, etc., were run from the upper end of this section to Pembina and other points on the Red River. This navigation appears, however, to have been discontinued.

THE BOIS DE SIOUX AND LAKE TRAVERSE.

Lake Traverse is the source of the Bois de Sioux, the tributary that, in connection with the Otter Tail River, forms at Breckenridge the Red River of the North. The general direction of the Bois de Sioux and Lake Traverse is north and south, and constitutes part of the western boundary of the State of Minnesota.

The lake is about 30 miles long, with banks gradually sloping up to the prairie level, 60 feet above. In low water more than one-half the area is dry. At the upper (south) end the water is 16 miles long by 1 mile wide, while the marsh at the lower end is from 2 to 4 miles wide, with frequent ponds of water, and intersected by a number of sloughs which unite at the lower end and form the Bois de Sioux. A railroad crosses this end of the lake with the grade about 5 feet above the low-water level.

The range between high and low water is about 4 feet. During high-water periods the lake covers an area of about 50 square miles and

discharges a large quantity of water, but in dry seasons no water escapes.

The Bois de Sioux from Lake Traverse to its junction with the Otter Tail River at Breckenridge is about 50 miles long, though the distance is only 22 miles by land. In the first 8 miles of the valley the river is merely a slough through low marshy ground. In the remaining distance the banks are tolerably well defined. The fall from Lake Traverse to Breckenridge is estimated at 5 feet. The whole river is practically a part of Lake Traverse.

BIG STONE LAKE.

Big Stone Lake is on the head waters of the Minnesota River. It forms part of the boundary between the States of Minnesota and South Dakota. It is a fine sheet of water, 25 miles long, $\frac{1}{2}$ mile to 1 mile in width, and about 10 feet in depth. Its low-water area is 18 square miles. The banks are well defined and slope rapidly to the prairie level, about 60 feet above. At the ends of the lake, marshes and meadows fill the valley.

Big Stone Lake and Lake Traverse occupy the same valley; a piece of low land $4\frac{3}{4}$ miles in length, called Browns Valley, separates them and forms the divide between the Red River of the North and the Minnesota River. The latter enters Browns Valley from the west near the upper end of Lake Traverse and continues its course to about midway between the bluffs, where it turns sharply to the south and flows into Big Stone Lake. The elevation of the Minnesota River at its point of entrance into the valley is about 3 feet above Lake Traverse. In times of freshets the river overflows its banks and frequently discharges into both lakes. Low water in Big Stone Lake is 7.71 feet below Lake Traverse. The general elevation of Browns Valley is about 10 feet above Lake Traverse and 17 feet above Big Stone Lake.

The usual range between high and low water in Big Stone Lake is 5 to 10 feet. It is plain that the lake could be made into a serviceable reservoir for the benefit of the Minnesota River by the impounding of surplus waters during the seasons of high water, the only question as to its practicability being the water supply and the expense of land damages. In 1882 the latter were estimated at $60,000 for a 10-foot rise in the lake. Beyond the 10-foot contour the damages would be far greater. The water supply, coming as it does from the treeless plains of Dakota, is a matter of extreme doubt.

The following appropriations have been made from time to time for the improvement of the Red River of the North:

By act approved August 14, 1876	$10,000.00
By act approved June 18, 1878	30,000.00
By act approved March 3, 1879	25,000.00
By act approved June 14, 1880	20,000.00
By act approved March 3, 1881	18,000.00
By act passed August 2, 1882	10,000.00
By act approved July 5, 1884	10,000.00
By act approved August 5, 1886	46,947.65
By act of August 11, 1888	20,000.00
By act approved September 19, 1890	25,000.00
Total	214,947.65

The present project under which operations are carried on consists in the removal of snags, leaning trees, and bowlders, and in dredging channels through the bars between Breckenridge and the northern boundary line.

This was based upon a mistaken idea of the discharge of the river during low-water seasons. The experience of recent years, however, is conclusive in showing that it was only reasonable to expect many low-water seasons during which the normal discharge of the river is wholly insufficient for the purposes of navigation.

An examination of the table of slopes shows the general slope of the river to be extremely small, and this, taken in connection with its narrow, canal-like character, will render comparatively small accretions in water volume very efficacious in affording navigable depths. An increase of 1,000 cubic feet per second to a low-water discharge of 350 cubic feet per second would render further operations under our project for improvement unnecessary and make an exceedingly fine line of water transportation.

In order to furnish this increase to the volume of discharge, the waters from the watershed of Red Lake could be assembled in one reservoir, and those from the Otter Tail might be gathered in Lake Traverse as a reservoir by means of a dam at Breckenridge. This would seem to be a feasible and economical method of solving the question of the improvement of the Red River of the North permanently, and hence I consider the matter worthy of the favorable attention of the Government. In order that it may be fully investigated and the estimates called for submitted, a survey will be necessary, for which purpose I estimate the sum of $6,000 will be necessary.

A sketch map of the river and surrounding country is herewith.*

COMMERCIAL STATISTICS.

(From annual report for fiscal year ending June 30, 1890.)

There are two steamboat lines now on the Red River: At Fargo, N. Dak., the Grandin Line, one steamer, *The Grandin*, 220 tons, with 4 barges, 2 of 300 tons, 1 of 250 tons, and 1 of 200 tons; at Grand Forks, the Red River Transportation Company, two steamboats, the *Pluck*, 36 tons, and the *H. W. Alsop*, 157 tons, with 10 barges, 4 of 178 tons, 1 of 202 tons, 1 of 155 tons, 1 of 116 tons, and 3 of 72 tons.

Comparative statement of freight moved by steamboats and barges during the past eleven years.

	Tons.		Tons.
1889	3,866	1883	25,314
1888	12,140	1882	31,652
1887	10,405	1881	26,557
1886	10,507	1880	21,651
1885	23,043	1879	17,859
1884	29,046		

Very respectfully, your obedient servant,

W. A. Jones,
Major, Corps of Engineers.

Brig. Gen. Thomas L. Casey,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. Engineer Office,
Detroit, Mich., *March 2, 1891.*

Respectfully forwarded.

An examination of this report reveals the fact that, although nearly $200,000 have been expended upon the improvement of the Red River of the North within the last fifteen years, but little commerce has been developed.

* Not printed.

In the eleven years for which statistics are given the aggregate volume of freight transported was only about 212,000 tons, an average of less than 20,000 tons per year. During the four years from 1886 to 1889, both inclusive, the average was only 9,100 tons, and for the year 1889 only 3,866 tons.

Notwithstanding the expenditure of more than $75,000 towards improving the river between the years 1883 and 1889, both inclusive, its commerce appears to have steadily declined during that period from 31,652 tons in 1882 to 3,866 in 1889.

This exhibit is surely discouraging. The situation is principally due to two causes: First, the difficulty of so improving such a stream as to make navigation easy and cheap; second, the extension into the tributary territory of several railroads, which serve the people more satisfactorily than is possible by way of the river.

If the question were now an original one, I should feel myself compelled to express the opinion that the river is not worthy of improvement by the General Government; but, by ten successive appropriations, the highest authority has sanctioned the efforts heretofore made to improve navigation on this river, and this action must be accepted as imperatively demanding the completest possible examination of the situation and conditions, as they now exist, before expressing an adverse opinion.

With the foregoing explanation and with a view to securing the surveys and examinations which I deem necessary before reaching a conclusion, I express the opinion that the river in question is worthy of improvement by the General Government.

O. M. POE,
Colonel, Corps of Engineers,
Division Engineer, Northwest Division.

SURVEY OF RED RIVER OF THE NORTH AND TRIBUTARIES ABOVE FERGUS FALLS AND CROOKSTON, MINNESOTA, AND OF BIG STONE LAKE, MINNESOTA AND SOUTH DAKOTA, WITH A VIEW TO IMPROVING NAVIGATION THEREON BY THE ERECTION OF SUITABLE DAMS OR BY SUCH OTHER MEANS AS MAY BE DEEMED BEST.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 11, 1892.

GENERAL: I have the honor to make the following report upon the survey of Red River and tributaries above Fergus Falls and Crookston, and of Big Stone Lake, with a view to improving navigation thereon by the erection of suitable dams, or by such other means as may be deemed best, together with an estimate of cost.

The following is a general description of the locality:

GENERAL CONSIDERATIONS.

The Red River of the North flanks the border between the forest of Minnesota lakeland and the great prairie which sweeps away to the west through the Dakotas. Along substantially a meridional zone, the great forest fades through insensible gradations into the grasses and flowers of the prairie, through which in a bed of clay the river winds its way in a general north direction to Lake Winnipeg.

Many indications point to the time when the river flowed in a directly opposite direction, and carried the waters of the Saskatchewan and

Assiniboine rivers in a mighty prehistoric Mississippi to the Gulf. General Warren has aptly reasoned that the south-flowing waters were turned backwards by a lifting up of the land which had its maximum effect upon the valley of the river between two great lakes whose dwindled descendants are now called Big Stone Lake and Lake Traverse.

The river is formed by the junction of the Otter Tail and Bois de Sioux rivers, the former being a continuation of the ancient valley and drawing its waters almost entirely from the prairie country, while the latter gathers its supply from the western borders of the forest lake country.

It is a narrow, sluggish, tortuous stream, subject to excessive variations in volume. It drains an area of 32,000 square miles of fertile country in the States of Minnesota and North Dakota. Together with one of its tributaries, the Bois de Sioux, it forms the boundary between those States.

The region drained in Minnesota lies west of the Mississippi and north of the Minnesota basins: in Dakota, east of the basins of Devils Lake and James River.

The tributaries from the west, coming entirely from prairie country are inconsequent during the present condition of rainfall. From the east the principal supply of water is drawn from the Otter Tail and Red Lake rivers, which are fed from the forests of Minnesota lakeland.

The Bois de Sioux is 50 miles long and forms the outlet of Lake Traverse.

The banks of Red River are of clay. In height they increase from 12 feet at Breckinridge to 50 feet at Pembina. The bed is mainly of clay, with some gravel and bowlders near old Fort Abercrombie and at Goose Rapids. In the former locality there is a stretch of about 20 miles of river which has a considerable slope, 1.36 feet per mile, resulting from great masses of bowlders which encumber the channel. It is more than probable that with the removal of these bowlders and some dredging, this slope can be reduced so that with a uniform discharge of 1,200 cubic feet per second no further improvement will be needed.

The Red River of the North flows through a plain of soft alluvium underlaid with a great bed of clay. At scattering intervals on this plain occur small deposits of drift in the shape of small bowlders, cobblestones, and gravel composed of several varieties of crystalline rocks and a well defined fossiliferous limestone. At Conollys and Goose Rapids the river has cut through a number of these deposits, and the removal of soft material has allowed the drift to settle and concentrate upon the surface of the river bed until it forms a sort of pavement which the river can no longer affect. This material restricts the channel and creates the rapids. Its removal will distribute the slope over such long reaches of low slope as to obviate the obstructions.

The slope of the river is small and strikingly uniform. The improvements to be suggested promise to practically convert the river into a great canal. The total fall over 395.5 miles to the international boundary is 194.5 feet or about 0.49 feet per mile. The maximum slope is at the rapids above mentioned.

WATER VOLUMES.

Until 1886 the lowest volume at Moorhead was considered to be about 500 cubic feet per second. In 1874 the low-water volume at Breckenridge was placed as high as 1,000 cubic feet per second, based upon: "Information that covers the last twenty years." Since 1886 the low-water volume has been reduced one-half.

During excessive dry periods the Bois de Sioux is merely pools of water connected by dry bars. The Otter Tail furnishes the supply at Breckenridge, about 200 cubic feet per second.

From here to Moorhead this amount is increased by, say, 50 cubic feet per second. Down to Grand Forks another increment of 50 is added, and there it meets about 200 cubic feet per second coming in from Red Lake River, thus making about 500 cubic feet per second as the low-water volume at that point. From here to the boundary line probably 100 cubic feet per second is added.

RULING DEPTHS.

For the extreme low-water stage of 250 cubic feet per second at Moorhead, the ruling depths are about as follows:

	Inches.
Breckenridge to Moorhead	6
Moorhead to Goose Rapids	12
Goose Rapids	6
Goose Rapids to Grand Forks	12
Grand Forks to Boundary line	30

For the stage corresponding to 500 cubic feet per second at Moorhead we have—

	Inches.
Breckenridge to Moorhead	12
Moorhead to Goose Rapids	18
Goose Rapids	18
Goose Rapids to Grand Forks	18
Grand Forks to Boundary line, say	36

The following table shows the length, width, depth, high and low water volumes, height of banks, and flood level.

From—	To—	Distance in miles.		Slope.	
		By river.	By land.	Total fall.	Average per mile.
				Feet.	*Feet.*
Breckenridge	Fort Abercrombie	26.00	......	35.5	1.36
Fort Abercrombie	Moorhead	71.00	......	38.2	....
Moorhead	Goose Rapids	98.06	......	50.658	0.516
Goose Rapids	Frog Point	21.96	......	21.169	....
Frog Point	Grand Forks	35.00	22	12.8	0.365
Grand Forks	Turtle River	25.00	18	6.2	0.403
Turtle River	Big Salt River	30.50	13	20.661	0.293
Big Salt River	Lower end Pelican Bars	40.00	17		
Pelican	Boundary line	48.00	28	9.333	0.194
Total		395.52	......	194.521	....

From—	To—	Slope. Maximum.				Width of river.
		At—	Length.	Fall.	Average per mile.	
			Miles.	*Feet.*	*Feet.*	*Feet.*
Breckenridge	Fort Abercrombie.	Conollys Rapids	....	....	2.446	125
Fort Abercrombie	Moorhead	....	....	....	1.389	95
Moorhead	Goose Rapids	....	....	....	....	100
Goose Rapids	Frog Point	Upper end of Goose Rapids.	.928	4.6	4.95	160
Frog Point	Grand Forks	....	....	....	....	100–200
Grand Forks	Turtle River	Turtle River Bars	5	....	....	....
Turtle River	Big Salt River					250–300
Big Salt River	Lower end Pelican Bars.	....	....	....	....	
Pelican	Boundary line	....	....	....	....	

From—	To—	Height of banks.	Low-water volume.	High-water volume.	Range between high and low water mark.
Breckenridge	Fort Abercrombie.	12 feet	At Breckenridge, 200 cubic feet per second.		At Breckenridge, 16 feet.
Fort Abercrombie.	Moorhead	At Moorhead, 37½ feet.	At Moorhead, 250 cubic feet per second.	At Moorhead, 20,000 cubic feet per second.	At Moorhead, 32.8 feet.
Moorhead	Goose Rapids			At Elm River, 30,000 cubic feet per second.	At Elm River, 36.2 feet. At Caledonia, 39.6 feet.
Goose Rapids	Frog Point	At Frog Point, 61½ feet.			
Frog Point	Grand Forks		At Grand Forks, 500 cubic feet per second.		At Grand Forks, 42.5 feet.
Pelican	Boundary line.	At Pembina, 50 feet.	At Boundary line, 600 cubic feet per second.	At Pembina, 40,000 to 50,000 cubic feet per second.	At Pembina, 38.5 feet.

LAND-SLIDE BARS.

The river varies in width between 100 and 300 feet, and lies in a very narrow valley with steep slopes subject to its action. There is no flood plane to the present river, but the ancient river had one in the great plain now known as the Red River Valley.

The steep banks are much subject to sliding in great masses into the river, sometimes temporarily damming it, frequently forming bars which almost obstruct navigation. It will always be necessary to maintain upon the river a dredging plant to meet the contingencies suddenly arising from these slides.

OTTER TAIL RIVER.

This is a Minnesota stream, and takes its rise in a system of lakes in the timbered country adjoining the Mississippi watershed upon the west. An examination was made of it in 1886.

For about 10 miles below Fergus Falls the Otter Tail River is full of bowlders; the descent is sharp, and a number of small rapids occur. In the next 10 miles the slope reduces, although the current is rapid and the bed of the stream is obstructed by large quantities of bowlders. The remainder of the river to Breckenridge, about 50 miles in distance, is comparatively sluggish, with a depth of about 3 feet, and average width of 70 feet at ordinarily low-water stage.

THE BOIS DE SIOUX, LAKE TRAVERSE, AND BIG STONE LAKE.

Lake Traverse is about 30 miles long, with banks sloping up to the prairie level from 60 to 150 feet above. In the present low-water stage more than half the area is dry. At the upper or south end the water is 16 miles long by 1 mile wide, while the marsh at its lower end is from 2 to 4 miles wide, with frequent ponds of water, and intersected by a number of sloughs which unite at the lower end in the Bois de Sioux.

A railroad crosses this end of the lake, with grade about 5 feet above the low-water level. The range between high and low water is about 4 feet. At high water the lake covers an area of about 50 square miles.

The Bois de Sioux is about 50 miles long. For about 8 miles it is merely a slough of the lake. In the remaining distance the banks are tolerably well defined, and there is supposed to be a fall of about 25 feet.

Big Stone Lake is on the head waters of the Minnesota River. It is about 25 miles long, from 1 to 2 miles wide, and lies in a deep gash in the prairie about 150 feet below its level. Its low-water area is about 18 square miles. The banks are well defined and the narrow valley slopes steeply up to the prairie level. At the lower end marshes and meadows fill the valley.

A strip of low land about 5 miles long separates it from Lake Traverse, and upon this is located the small town of Browns Valley.

The Minnesota River enters Browns Valley from the west near the upper end of Lake Traverse, and continues its course to about midway between the bluffs, where it turns sharply to the south and flows into Big Stone Lake. At its point of entrance into the valley it is only 3 feet above Lake Traverse. During freshets it frequently overflows its banks and discharges partly into the latter lake.

Low water in Big Stone Lake is 7.71 feet below that of Lake Traverse. The general elevation of the Browns Valley strip is 10 feet above Traverse and 17.7 above Big Stone.

The usual range between high and low water is from 5 to 16 feet.

RED LAKE.

Red Lake is situated in northern Minnesota, in the midst of a region which is to-day wholly uninhabited except by the Indians in and about the Red Lake Agency. It lies in the midst of a magnificent pine forest, except that from its very waters upon the north and northwest a great swamp stretches across to the Canadian boundary. Considerable hardwood timber is found near the waters of the lake and its tributaries.

The Indians of Red Lake have cultivated quite an area of ground with much success, and when I visited the locality in early summer their crops looked better and were further advanced than any in middle or northwestern Minnesota. This proves that the country is rich in agricultural resources. The lake is in two great bodies, connected by a narrow strait. Its greatest length is 50 miles. The width and length of both bodies are nearly alike, being about 12 and 25 miles respectively. The area is 486 square miles. Along the south shore of the southern lake an enormous flat extends many miles out into the lake, with scarcely enough water to float a canoe in many parts. Wherever deep water comes up to the shore great masses of bowlders have been piled upon the beach by the action of ice in winter.

RED LAKE RIVER.

The following is from the report of Maj. Chas. J. Allen, Corps of Engineers, in 1886:

Red Lake River discharges into the Red River of the North opposite Grand Forks. From the lake the distance is about 325 miles by water. The river, which is very tortuous, may be divided into three sections, viz: From Red Lake to the mouth of Thief River, 125 miles; Thief River to Fishers Landing, 160 miles; from the latter point to the mouth, 40 miles. From Red Lake to Thief River the stream is sluggish, with a general width of 200 feet, and depth of 2 feet at low water; flows through a generally open prairie, and is bordered more or less by marshes. * * * With the exception of occasional bowlders in the bed of the stream, no obstruction to a 2-foot navigation exists between Red Lake and the mouth of the Thief River. From Thief

River to Fishers Landing the bed of the stream is encumbered by immense quantities of bowlders and occasional small rapids. On this section of the river are two dams for the utilization of water power—one at Red Lake Falls, with a head of 15 feet; the other at Crookston, head, 10 feet. From Fishers Landing to the junction with Red River the current is sluggish, the width averaging 150 feet and depth at low water being 2¼ feet.

SURVEY AND PROJECT.

The sum of $2,000 having been allotted to me from the appropriation, for examinations, surveys, and contingencies of rivers and harbors for the purpose of making this survey, and upon my estimate of $6,000 for the said purpose, a party was organized and placed in the field June 24. It consisted of—

	Per month.
1 Assistant engineer	$125
1 Assistant engineer	90
1 Recorder	50
2 Rodmen	40
2 Axmen	30
1 Flagman	25

Its object was to gather data from which I might determine whether sufficient watersheds and holding ground were available to afford water enough during low stages of the Red River of the North to make the said river navigable without other works for improvement. For this purpose two localities for holding large bodies of water conspicuously offered themselves: (1) Red Lake, (2) Lake Traverse.

The watershed of Red Lake is approximately 1,930 square miles, of which 486 square miles is lake surface. The watershed of Lake Traverse alone is not large enough to gather sufficient water, and the water level of the lake has in consequence been considerably lowered during the recent dry years. Its outlet, the Bois de Sioux River, was supposed to have a slope so low as to enable the waters of the Otter Tail River to be turned into it by a dam near Breckenridge, Minn. This would develop drainage area of 3,453 square miles, of which 400 square miles is lake surface.

The survey operations were first directed to an examination of the Bois de Sioux River, and were extended up to the point where a flowage line from a dam at Breckenridge intersected the river banks. This proved to be at a point 17 miles above Breckenridge, where quite a slope was found in the river. This seemed to terminate the Lake Traverse proposition and the party was moved to Red Lake by way of Fosston. Here the difficulties of the work in hand assumed considerable proportions. The lake is bordered by dense forests and thickets, except on the northwest and west, where the shores are almost wholly marsh. It was hoped to meander the whole lake and determine rudely a 2-foot flowage line, but the difficulties incident to work in such country proved too great and the party had to be recalled, the funds being exhausted before the work was finished. The party suffered severely from flies and mosquitoes, particularly when in the midst of the long grasses of the marsh country. Before sending it to Red Lake I had ordered Mr. R. Davenport, assistant United States engineer, to make an instrumental reconnaissance to gather data to guide in directing further operations. His trip proved to be one of considerable hardship.

The main party moved from the Indian agency to the lake outlet and proceeded to take measurements to enable a discussion of a question of

a site for the dam, but it was found impossible to work among the tall grasses and reeds on account of the deer flies and mosquitoes, and the party retreated to its boats and the shore of the lake. On August 20 it was recalled without having finished its work, the sum of money allotted being wholly inadequate for such an extended and difficult piece of work.

From the information thus gathered from considerable personal observation, and from a reconnaissance by Mr. Davenport of the region between the Otter Tail River and the Bois de Sioux River, I gather the following:

I.—RED LAKE RESERVOIR.

Red Lake can probably be raised 2 feet by a dam on its outlet, and also it can be lowered about 2 feet by dredging across the shoal at its outlet, and inclosing the cut between dikes to prevent its filling up from wave action. This would afford ample accommodation for about two years rainfall, and would possibly relieve the Red River Valley from effects of floods on the Red Lake River. The output of the reservoirs on the Mississippi River above Pokegama during the year 1891 was, rudely, at the rate of 10,000,000 cubic feet per square mile. There was rather less than an average precipitation. Now, assuming that the precipitation in the two water sheds before us is 90 per cent of that of northern Minnesota, we have 9,000,000 as an approximate output per square mile in a year of average rainfall, which simply means that half the time the output will be more than this, and half the time it will be less.

We will then have, for the Red Lake reservoir, 1,930 square miles × 9,000,000 = 17,370,000,000 cubic feet for the average output of water in one year.

This will permit supplying the river as follows:

	Cubic feet.
800 cubic feet per second for 214 days	14,791,680,000
250 cubic feet per second (about) for 152 days	2,578,320,000
	17,370,000,000

It is here assumed that the river is free from ice and open for navigation from April 15 to November 15, being two hundred and fourteen days, and that during the remainder of the year, one hundred and fifty-two days, it is closed to navigation. The effect of this reservoir would be to maintain a uniform stage during the boating season.

II.—LAKE TRAVERSE RESERVOIR.

By damming the river the waters of the Otter Tail can be diverted in a canal across the flat marshy country southeast of Breckenridge, and brought into the Bois de Sioux via the Rabbit River. The approximate line is shown on the map herewith. The distance is about 8 miles. Then by placing a reservoir dam on the Bois de Sioux just below the mouth of Rabbit River, sufficient height could probably be obtained to back the waters into Lake Traverse for a reservoir. The quantity of water which could therein be impounded can not reasonably be estimated without more measurements to determine the areas overflowed at different heights, but the quantity obtainable from the watershed may be approximately stated. Its area is about 3,450 square miles: 3,450 × 9,000,000=31,050,000,000 cubic feet.

This would permit supplying the river as follows:

	Cubic feet.
1,200 cubic feet per second for 214 days	22,187,520,000
250 cubic feet per second for 152 days	2,783,200,000
Overplus for Minnesota River	6,079,280,000
	31,050,000,000

Thus maintaining in the Red River a uniform navigable stage during the entire boating season.

The Lake Traverse reservoir would have an approximate capacity of 20,000,000,000 cubic feet only, but the remainder of the gathered waters would probably be easily held in the extensive lake portion of the watershed.

The following discharges of Red River of the North have been measured at various times:

(1) *At Moorhead.*

Date.	Stage (above low water).	Discharge (cu. ft. per second).	Date.	Stage (above low water).	Discharge (cu. ft. per second).
	′			′	
Aug. 1, 1879	1.0	663	June 10, 1880	5.0	2,678
Sept. 9, 1880	1.9	895	Apr. 28, 1882	11.0	4,421

(2) *At head of Goose Rapids.*

Gauge.	Discharge (cu. ft. per second).	Gauge.	Discharge (cu. ft. per second).
1.3 feet (low water)	1,026	4.0 feet	2,077
2.0 feet	1,076	5.0 feet	2,686
2.5 feet	1,185	6.0 feet	3,762
3.0 feet	1,320	7.0 feet	4,071
3.5 feet	1,754		

Low-water stage gives 1 foot depth on Goose Rapids Bars. These are to be dredged under the current project. The work can be done in one season, probably that of 1892. One thousand two hundred cubic feet per second will therefore give 2.2 feet in addition to the depth excavated.

(3) *At Grand Forks.*

Date.	Gauge.	Discharge (cu. ft. per second).	Date.	Gauge.	Dicharge (cu. ft. per second).
Aug. 16, 1889	—1.25	466	Oct. 25, 1888	0.50	964
Sept. 13, 1890	—0.70	532	Oct. 24, 1891	1.45	1,525
Nov. 8, 1886	—0.65	513	Oct. 8, 1891	2.80	2,384
Sept. 9, 1891	—0.10	733	Oct. 7, 1891	2.9	2,659
Sept. 14, 1891	—0.20	792	Aug. 15, 1882	4.8	3,277
Sept. 15, 1891	—0.10	797	Aug. 15, 1882	4.8	3,400
Sept. 16, 1891	+0.05	851	Aug. 15, 1882	4.85	3,262
Sept. 25, 1891	0.20	961	Aug. 15, 1882	4.85	3,274
Sept. 26, 1891	0.20	955			

From Table No. 3 the following approximate relation between the volume of discharge and the reading on the gauge has been deduced:

River stages at Grand Forks as affected by volume of discharge.

Discharge (cubic feet per second).	River stage.
400	—1.5 feet. (Below zero.)
550	—1.0 foot. (Below zero.)
700	—0.5 foot. (Below zero.)
900	0.0
1,000	0.5 foot. (Plane of reference for standard low water project requires 4 feet of water at this stage.)
1,250	1.0 foot.
1,500	1.5 feet.
2,000	2 feet.

It thus appears that if we make the volume of discharge at Grand Forks about 2,000 cubic feet per second, we may expect a navigable draft of 5½ feet in the river below.

Also, if we make the volume of discharge passing Moorhead and Goose Rapids 1,200 cubic feet per second, we may expect a gauge reading of about 2½ feet at the former, and a depth of 2½ feet in excess of that to be excavated at Goose Rapids.

Just what effect may be expected above Goose Rapids cannot be estimated with the data on hand, but we may expect a river navigable for small craft.

It is thus reasonable to expect that the two reservoirs above described will furnish sufficient water to render the Red River continuously navigable during the whole open season from the Rabbit River dam to Lake Winnipeg. And further: By placing a lock in the Rabbit River dam navigation would be extended to the head of Lake Traverse; and still further: Measurements taken by Mr. Davenport in 1882 show that Big Stone Lake is only 7 feet below the level of Lake Traverse. Hence if we place a dam across the outlet of the former and cut a short canal between the two, navigation would be extended to the foot of Big Stone Lake, thus creating a water transportation line 615 miles in extent, without counting Lake Winnipeg and the Saskatchewan River.

It is probable that the creation of these two reservoirs would relieve the Red River Valley from a considerable portion of the effects of floods.

There is still another aspect to this matter. The stored-up waters in Red Lake distributed uniformly during the open season through Red Lake River would render it navigable for small craft.

One or more dams and locks at the falls, near Thief River, and at Crookston, would enable boats to pass up to the reservoir dam; passing this by means of a lock, they could proceed to the head of the lake. From this point to Rainy Lake River there is a marsh all the way, a distance of 55 miles, and hence a canal could be cheaply constructed across, and an outlet via Crookston and Grand Forks would thus be afforded for the timber and other products of the extensive Rainy Lake country, which at present has no outlet in the United States.

ESTIMATES.

In the absence of the proper surveys only approximate estimates can be submitted.

Red Lake Dam and Lock	$150,000
Rabbit River Dam and Lock	150,000
Canal to divert the Otter Tail River across the Breckenridge Flats—length, 8 miles (14,080 yards); breadth, 60 feet; depth, 6 feet—say 600,000 cubic yards, at 10 cents	60,000
Dam across Otter Tail River	20,000
Dam at foot of Big Stone Lake	150,000
Canal between Big Stone Lake and Lake Traverse—2 miles, at $15,000	30,000
Dam and Lock at Thief River	150,000
Surveys	50,000
Contingencies	100,000
Total	860,000

That is to say, for the sum of $860,000 we may reasonably expect to create water transportation lines as follows:

	Miles.
Lake Winnipeg to the foot of Big Stone Lake	615
Red Lake River	325
Red Lake	50
	990

That is to say, something like 1,000 miles of transportation line would be created, at a cost not exceeding $1,000 per mile.

No estimate is here made for purchase of damaged lands, and the whole estimate should be considered as approximate and subject to the revision which will result from the measurements of a careful survey.

RED LAKE CANAL.

A canal 55 miles long from Red Lake to Rainy River would require no locks. It should be 120 feet wide and 6 feet deep. It ought to be made for $15,000 per mile.

BIG STONE LAKE RESERVOIR.

It would hardly be reasonable to pass by the effects of this reservoir upon the Minnesota and Mississippi rivers. This reservoir, with 10 feet of rise, would carry 5,227,235,000 cubic feet; which, added to the surplus from Lake Traverse, would make, say, 11,306,000,000 cubic feet.

But the probable average output of the drainage area of the lake is 20,145,897,048 cubic feet.

Hence, if additional holding ground can be found below Big Stone Lake, and this is probable, we could reasonably expect to have for the Minnesota River 26,225,177,000 cubic feet during the whole of an average year.

This would permit the following discharge into the river: One thousand eight hundred cubic feet per second for 92 days during the extreme low-water period of August 15, September, October, November 15; 926 cubic feet per second for 122 days during April 15, May, June, July, August 15; 200 cubic feet per second for 152 days, or during the winter months when rivers are frozen up.

It is evident that 1,800 cubic feet per second added to the Mississippi between St. Paul and the mouth of the St. Croix during extreme low

stage will have considerable effect upon that reach of river, and probably enable boats to reach St. Paul during the whole boating season.

During the year 1891, when the Mississippi River fell to a zero stage at points just below the influence of the reservoirs on its headwaters, these reservoirs maintained a stage of about 1.5 at St. Paul.

From the following table of gaugings made in the same year it appears that had 1,800 cubic feet per second been added from the Minnesota the combined reservoir effect would have produced a stage of over 2.5 at St. Paul. At this stage boats from St. Louis can readily come up.

Gaugings of the Mississippi River at St. Paul, July 1, 1891, to November 14, 1891.

Date.	Gauge reading.	Volume.	Date.	Gauge reading.	Volume.
July 1	2.78	5,773.27	Sept. 10	1.20	3,328.44
2	2.89	5,866.25	11	1.40	3,482.96
3	2.70	5,663.15	12	1.07	3,233.53
6	2.10	4,857.89	14	1.55	4,227.92
10	2.54	5,420.16	15	1.34	3,614.30
11	2.46	5,162.51	16	....	....
13	2.75	5,690.07	17	1.40	3,767.84
14	2.46	5,373.48	18	1.34	3,512.16
15	2.27	5,046.35	19	1.23	3,327.51
16	2.01	4,821.09	21	1.15	3,244.63
17	1.96	4,662.35	22	1.38	3,538.58
18	1.90	4,574.56	23	1.07	3,111.75
20	1.94	4,948.04	24	1.31	3,386.15
21	2.01	4,656.38	25	1.28	3,287.82
22	1.91	4,596.75	26	1.24	3,428.81
23	1.96	4,637.77	28	1.50	3,678.28
24	2.00	4,731.68	29	1.62	3,956.24
25	2.00	4,675.77	30	1.60	3,893.81
27	1.97	4,516.15	Oct. 1	1.56	3,875.35
28	2.11	4,860.72	2	1.70	3,981.58
29	2.01	4,786.07	3	1.85	4,210.55
30	2.09	4,808.89	5	1.63	3,909.09
31	2.30	5,259.40	6	1.80	4,242.02
Aug. 1	2.09	4,843.49	7	1.45	3,606.50
3	1.80	4,473.76	8	1.60	3,963.94
4	1.99	4,566.43	9	....	....
5	1.80	4,399.84	10	1.50	3,824.89
6	1.80	4,363.60	12	1.35	3,537.39
7	1.84	4,390.58	13	1.50	3,808.86
8	1.92	4,472.47	14	1.45	3,720.91
10	1.96	4,659.21	15	1.45	3,761.12
11	1.71	4,136.35	16	1.40	3,648.76
12	1.49	3,760.23	17	1.27	3,458.31
13	1.47	3,626.33	19	1.40	3,710.14
14	1.23	3,507.55	20	1.50	3,830.91
15	1.54	3,908.40	21	1.48	3,894.75
17	1.51	3,961.19	22	1.48	3,780.80
18	1.63	3,963.01	23	1.32	3,543.49
19	1.30	3,548.14	24	1.21	3,539.56
20	1.86	4,200.84	26	1.18	3,459.02
21	1.68	4,109.58	27	1.46	3,692.73
22	1.50	3,738.54	28	1.35	3,535.92
24	1.36	3,674.88	29	1.41	3,658.90
25	1.61	3,892.53	30	1.38	3,590.47
26	1.46	3,764.19	31	1.32	3,612.36
27	1.46	3,746.77	Nov. 3	1.38	3,578.93
28	1.34	3,532.92	4	1.10	3,192.95
29	1.25	3,366.80	5	1.31	3,446.98
31	1.48	3,665.06	6	1.11	3,189.88
Sept. 1	1.49	3,792.81	7	0.97	3,036.18
2	1.47	3,636.44	9	0.82	2,686.20
3	1.35	3,555.24	10	1.00	2,088.85
4	1.31	3,476.63	11	0.54	2,422.52
5	1.29	3,300.22	12	0.90	2,824.35
7	1.70	4,323.20	13	0.65	2,507.87
8	1.49	3,626.98	14	0.80	2,742.97
9	1.25	3,208.58			

Still further: By constructing the necessary dams for slack-water navigation on the Minnesota River, there would be opened to navigation a line extending through Lake Winnipeg into the Saskatchewan River, which is understood to be capable of navigation over a very long distance.

COMMERCIAL STATISTICS.

There are two steamboat lines now on the Red River of the North: At Fargo, N. Dak., the Grandin line of one steamer, 220 tons, with 4 barges, 2 of 300 tons, 1 of 250 tons, and 1 of 200 tons. At Grand Forks the Red River Transportation Company have 2 steamboats, the *Pluck* and the *H. W. Alsop*, with 10 barges, 4 of 178 tons, 1 of 202 tons, 1 of 155 tons, 1 of 116 tons, and 3 of 72 tons.

Freights during past twelve years.

	Tons.
1889	3,866
1888	12,140
1887	10,405
1886	10,507
1885	23,043
1884	29,046
1883	25,314
1882	31,652
1881	26,557
1880	21,651
1879	17,859

A map of the locality is submitted.*

Very respectfully, your obedient servant,

W. A. JONES,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

*Not reprinted; printed in House Ex. Doc. No. 127, Fifty-second Congress, first session.

APPENDIX A A.

IMPROVEMENT OF MISSOURI RIVER ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

INPROVEMENTS.

1. Missouri River between the Great Falls, Montana, and Sioux City, Iowa.
2. Yellowstone River, Montana and North Dakota.

EXAMINATION AND SURVEY.

3. Missouri River, Montana, between Great Falls and cañon next below Stubbs Ferry.

ENGINEER OFFICE, UNITED STATES ARMY,
Sioux City, Iowa, July 15, 1892.

GENERAL: I have the honor to transmit herewith reports upon the river improvements in my charge for the year ending June 30, 1892.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF MISSOURI RIVER BETWEEN THE GREAT FALLS, MONTANA, AND SIOUX CITY, IOWA.

At the beginning of the year repairs were in progress on the dams of the upper part of the rocky river, viz, from Fort Benton, the head of navigation, to Carroll, Mont., for which reach only a project of permanent improvement existed; a steel hull snagging scow and a steel hull stern-wheel snag boat were being built for removal of snags, wrecks,

and other obstructions on the sandy river; three parties of the detailed and systematic survey of the river were in the field; office mapping of old work of the same was in full progress, and the selection from reports of previous examinations, of two sites for ice harbors was under consideration at the War Department.

During the year, and commencing at the head of the rocky river, the dam at Bakers Bar, the wing dam at Crocondunez, and three dams of the Fontanelle system were repaired and extended. To stop a cutting of the bank of the lower island at Fontanelle Bar, seven slips in the bank, graded from its top to a slope of 1 on 4, about 25 feet wide and 150 to 200 feet apart, were revetted with brush and stone, and the revetment continued a little beyond the bottom of the river trough. Two wing dams at Archers Bar, a sill across the left chute at Crow Coulee, and a dam at Norris Island, opposite Judith, were built. A cut of double width at Archers Bar and a single cut each at Churchills and Crow Coulee were dredged; the dredged material, gravel, cobble, some clay, and a little sand, aggregated 31,326 cubic yards. Two hundred and fifty-one bowlders or pieces of rock averaging about one-half cubic yard in size, and the largest having been about 2 yards, were removed from the channel and properly disposed of between Marias River and Iron City Island, 17 miles below Judith or 64 miles above Carroll.

All the work of the fiscal year named above was done in 1891; it put the channel to next below Judith in fairly good shape. The Shonkin Bar dam, the wing dam in Evans Bend, the dams on left bank at Crocondunez, two dams of the Fontanelle system, and the dams in Senieurs Reach were in good condition. Some heavy work remains on the rapids and bars below Judith, but operations on the rocky river have not been resumed since it appeared doubtful if boats would run this year on that part of the river. Good crops in the Dakotas have made better business for boats there. Furthermore, the bulk of the freight on the upper part of the Missouri is of Eastern shipment, and it seems that the through rail rate as compared with the rate from points where the railroads strike the river leaves a scant proportion for the boats. River interests look for relief to the building of the Sault Ste. Marie railroad to Bismarck.

The steel snagging scow built at St. Louis, and named *Mandan*, arrived at Sioux City September 6 under tow of the chartered steamer *Rosebud*, and commenced snagging September 8 under the same tow. On account of the long stretch of river to be covered her work was limited to the worst channel obstructions; it comprised the removal and proper disposal of 64 snags, 2 abandoned pontoon-bridge stone sinkers, and 4 stumps, and 2 overhanging trees from banks, between Sioux City and a point opposite Glencoe, N. Dak., 640 miles; the chartered towboat was withdrawn under terms of her contract, October 22, and the *Mandan* was then laid up for the winter.

The U. S. steamer *Josephine*, which had formerly been used on the rocky river, was fitted with iron shears, steam capstans and engines, and other appliances for snagging, and commenced such work at Bismarck October 2, 1891, and operated between Berthold and a point opposite Glencoe, N. Dak., 129 miles, in 1891, and between Berthold and the Big Bend, S. Dak., 457 miles, in 1892. She removed 156 snags, 59 overhanging trees and 14 stumps from the bank, and served during both seasons as tender to the survey quarterboats and parties. The *Josephine* also sluiced during the low water of 1891 a channel through the worst bar, one near Washburn, N. Dak., which formed the controlling depth on the route where the boating was then the busiest. This chan-

nel remained good during the rest of the low water, and from accounts received during this last spring had not filled up.

The steel hull stern-wheel snag boat built at Dubuque and named *James B. McPherson*, was received 108 days behind the agreed time of her completion and too late to get her to the district before spring. She operated between Sioux City and the Big Bend, S. Dak., 300 miles, removing and properly disposing of 102 snags, a pontoon-bridge stone sinker which had drifted into the channel, and 33 overhanging trees or stumps, and trimmed 6 overhanging trees.

It is the rule in the snagging work that the earth is cleaned from the stumps, the roots trimmed close, and the stumps placed, end up, on a fairly high bank and one not likely to cave soon, in order that the stumps may dry out and would float, so that they will not form any future obstruction. The trunks are generally worked into fuel for the boats where suitable, or sawed into several lengths and cast overboard, branches of overhanging trees are cut, the trees tied back, or, if about to cave into the river, disposed of in the same manner as snags. The snagging operations are very satisfactory to the steamboat people. In connection with other work of the snag boats snagging gives the best channel improvement for the cost. No snagging had ever been done on the Missouri River above Sioux City before last year. It will probably be required to extend operations of the snag boats over about the whole length of the sandy river, 1,300 miles, and it is desired to include the removal of bowlders. These are washed out of the bluffs or brought to the river by the swift tributaries and by freshets in the gullies, and are frequently distributed by ice along the channel. It is also desired to open channels through the worst bars at low water by steamboat sluicing. All of these works are of a temporary character and need to be repeated from season to season and year to year. The unending shifting of the river from caving of its banks, and from ice gorges and land clearing, make new snags and uncover old ones. My recommendation of last year is renewed, that the least estimate, $50,000 a year, for the removal of snags, wrecks, and other obstructions, and for temporary improvement at the shoalest channels, be made as a separate appropriation, and, in order that the work may be uninterrupted, that the appropriation be continuous, the same as for the operation of snag boats and dredge boats on the Upper Mississippi, and for the operation of snag boats on the Lower Mississippi and Ohio rivers, as provided for in the river and harbor acts of 1888 and 1890.

Of the fieldwork of the river survey, bench marks were placed and primary levels run from Poplar Creek, Montana, to Fairbank, S. Dak., 574 miles; the tertiary triangulation, hydrography, and topography were completed from Wolf Point, Montana, to next below Cannonball, N. Dak., 461 miles; and the triangulation and back topography run from end of the completed field work to Fairbank, S. Dak., 144 miles. The present field party will be followed, when low water obtains, by a hydrographic party, which will run the topography of immediate banks and low grounds. The separation of usual topographic and hydrographic work indicated has for its object better progress of field work for the year and the securing of low-water soundings and shore lines.

The sixty-three details charts of the river survey from Fort Benton, its beginning, to Wolf Point were completed, and all, except twelve, placed with the printer for publication; the preliminary or small-scale chart No. 1 was also completed, except title, and No. 2 one-half finished; the eight charts of this series to Wolf Point had been previously penciled for their prompt use in laying off limits of the detail

charts and for making quick tracings and blue prints for use in the field and as index sheets. The eight charts of the same series from Wolf Point to Cannon Ball were penciled and the fifty-eight detail charts of the same reach were three-fourths finished.

The approved location for an ice harbor at Rock Haven, near Mandan, N. Dak., was surveyed and plans drawn for its improvement for the purpose stated. It is expected with funds in hand to execute the improvement, as may be ordered, this fall.

It is also expected with a part of the same balance, and allotments which may be made from the appropriation of 1892, to continue the work of snagging, etc., and to complete the river survey.

The appropriation asked for 1894 other than the continuous item of $50,000 for removal of snags, wrecks, and other obstructions and temporary improvement at shoalest channels, is intended for—

Rectification of the river at Pierre and Fort Pierre, S. Dak	$150,000
One year's work or one-half rectification of river and permanent channel improvement of Bismarck reach, North Dakota, 25 miles	198,000
One year's work or one fourth of same rectification and improvement of Yankton-Sioux City reach, South Dakota and Nebraska, 130 miles	514,000
Plant and its maintenance for one year for Bismarck reach	60,000
Same for Yankton—Sioux City reach	150,000
Total	1,072,000

If the appropriation made be for two years, as is usual, then the amounts for works of the two reaches named above should be doubled, and $35,000 added for maintenance of plant for a year. Failing in the authority for the proposed works on the reaches, there would remain for consideration in addition to the snagging, the proposed Pierre and Fort Pierre work, $150,000, and similar work at Yankton, $75,000, heretofore estimated for, and which is now included in the proposed work of the Yankton—Sioux City reach.

The proposed works at Pierre and Yankton recommended last year, for stated reasons, are named in the appropriation act of 1892, but the amount therein for the whole Missouri River above Sioux City will only barely provide for the continuation of snagging, etc., and completion of the river survey, works already entered upon, and for the Yankton ice harbor, required by the act. During the year need has appeared for extension of the Pierre work to include Fort Pierre and vicinity. This arises from a bad condition of the Fort Pierre Landing and the probability that this will be needed for important river shipping upon the completion of a railroad now being built to that point from the Black Hills, for information of which see commercial statistics.

Heavy ice gorges are a bad characteristic of the Upper Missouri. They form in wide shoal places; the ice dam raises and builds back by means of the running ice from above, and with the high water damages property and sometimes causes violent changes of the river bed. The Vermillion Cut-off of 1881, at about the middle of the Yankton–Sioux City Reach, resulted from an ice gorge. It left that town and extensive Government river works there 2 miles inland, practically destroyed the town, did not leave a vestige of the settlement of Green Island, opposite Yankton, damaged and wrecked steamboats, and leveled fences and buildings from bluff to bluff. Adjoining this cut-off, and as its results, the river has been caving its banks, lengthening its course, and narrowing the necks of land at the bends, thus making wide shoal stretches and threatening new cut-offs.

Sibley Island, next below Bismarck, is another place near which damaging ice gorges have formed, and are likely to do so any year.

The two reaches proposed for permanent improvement include the worst ice-gorge places, short pieces of adjoining bad river, and other adjacent pieces where it is desired to fix the channel permanently along town fronts or at intended ice harbors. The reaches are further selected to terminate where the river is naturally good and fairly permanent, so that the works may not be undermined at the ends nor flanked by the river above or below.

The availability of the river above Sioux City for extensive traffic, when permanently improved, and the present and prospective appearance of greatly increased freights seeking transportation along that route, warrant the recommendation herein for such improvement at the most needed places and portions.

Money statement.

July 1, 1891, balance unexpended	$267, 896. 11
June 30, 1892, amount expended during fiscal year	156, 909. 30
July 1, 1892, balance unexpended	110, 986. 81
July 1, 1892, outstanding liabilities	17, 721. 47
July 1, 1892, balance available	93, 265. 34
Amount appropriated by act approved July 13, 1892	150, 000. 00
Amount available for fiscal year ending June 30, 1893	243, 265. 34
Amount (estimated) required for completion of existing project	*175, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1894	1, 122, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of contract, Improving Missouri River between the Great Falls, Mont., and Sioux City, Iowa, ending June 30, 1892.

No.	Name and address of contractor.	Date of contract.	Subject of contract.	Remarks.
1	Isaac P. Baker, Bismarck, N. Dak.	July 6, 1891	Charter of towboat	Completed October 22, 1891.

REPORT OF MR. H. C. GOULD, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *June 16, 1892.*

SIR: I have the honor to submit the following report of field operations on improvement of the "Rocky" River during the fiscal year ending June 30, 1892:

REPAIRS TO AND CONSTRUCTION OF DAMS.

Evans Bar (5¼ miles below Fort Benton).—Work commenced June 25, 1891. The old dam was connected to mainland by new work, 220 feet long, averaging 3 feet in height, across a low gravel bar, and a deep chute between the bar and shore. The other end was connected with high part of the island by new piece, 170 feet long, averaging 2½ feet high.

The ends were well protected by brush and rock and the whole dam thoroughly ballasted. There were used here 166 fascines, 486 yards rock from Labarge, 6 yards rock from banks, 150 poles, 520 sacks gravel, 585 days' labor.

This work was finished July 27, and preparations were made on the 28th to move the camp down the river.

*Exclusive of $50,000 annually for snagging, etc.

On the way down the party stopped a few hours at Croconduncz (9 miles from Fort Benton).

All the work here has held well and was in good condition, except the land end of the short wing dam on right bank, where the water was cutting under the brushwork on the bank. Two mats were placed here to stop the cutting, using 32 fascines, 8 yards rock, 8 days' labor, 8 poles, 25 sacks gravel.

Fontanelle Bar (12 miles from Fort Benton).—The river was rapidly cutting away the banks on left side along the lower island. It was desired to stop this cutting if possible. The high water early in July had also cut around the ends of some of the old dams and these places needed filling.

This work was commenced July 29. Seven places along the cutting bank, from 150 to 200 feet apart, were graded out by hydraulic sluicing, using the large pump on the grab boat. These slips were about 25 feet wide, on a slope of about 1 on 4, and were covered by a layer of brush fascines, 1 foot thick, well staked down and ballasted with rock, the covering extending from the top of the bank to the water and continued on the bottom well out to deep water by a line of mattresses sunk with rock. Total length of these wing dikes, about 490 feet.

The dams in the chute between this island and the one above it were made continuous and the lower end resting on the head of the island was thoroughly protected by a strong revetment of brush and rock. Length of dam repaired, about 400 feet.

A break about 40 feet wide was found in the old dam (No. 8) just opposite the above dam. This was filled with brush and stone.

There were used in the foregoing work 974 fascines, 186 poles, 775 stakes, 600 sacks gravel, 20 yards loose gravel, 435 yards rock, 309½ days' labor.

On August 21 the party was moved to Archer Bar (24 miles from Fort Benton), just below mouth of Marias River.

Two dams were built here across the channel on the right side, to throw the water into the dredged channel on left side of the bar.

The upper dam extends 260 feet from the bank, and consists nearly the whole length of two layers of fascines well ballasted with rock. The outer end was protected by additional fascines and rock, and the shore end extends up the bank 25 feet, the brush being staked down and well covered with rock. Materials used on this dam are 606 fascines, 147 poles, 203 days' labor, 46 stakes, 250 yards rock.

The lower dam extends 285 feet from bank across head of deep pocket to well out on the bar; in deepest part, where water was 6½ feet deep, seven layers of fascines were put in. The ends were protected as in the upper dam. The materials in this dam are 875 fascines, 153 poles, 60 stakes, 192 sacks gravel, 313 yards rock, 234 days' labor.

The July high water had caused some breaks in the large dam at Bakers Bar (2½ miles from Fort Benton). Some of the work on this dam had necessarily been done when the water was high, which prevented placing the ballast as well as it should have been done.

On September 15 a small party was taken up by the *Josie* with the 50-foot barge and camp outfit.

The repairs were finished and this party floated down on the 24th.

There were used in the repairs, 285 fascines, 52 poles, 1,275 sacks gravel, 30 yards rock, 143 days' labor.

On October 2 the party was moved to Crow Coulee Bar (32 miles from Fort Benton). Fascines and poles had previously been gotton out here for a submerged dam or sill across the left-hand chute. This consisted of a single layer of brush fascines well ballasted with rock; the ends were protected by large aprons of brush and rock. The length is 260 feet, and the following materials were used: 211 fascines, 56 poles, 25 stakes, 256 yards rock, 173 days' labor.

The party moved to Eagle Creek on October 10 and until October 30 was engaged in preparing incline and hauling out the dredge.

On October 31 the party moved to Judith (87 miles from Fort Benton). A high dam was built here across the chute between Norris Island and the left bank. The mainland end rests on a spur of the bluffs, composed of clayey earth, large gravel, and bowlders; the rock for the dam was obtained by digging out and blasting these bowlders. The other end extends well up on the sand island and was protected by a large apron of brush and rock. Five layers of fascines were put in except at the ends, each tier well ballasted with gravel, and the two top tiers with rock. The length is 150 feet, and the following materials were used: 719 fascines, 962 sacks gravel, 239 days labor, 120 yards loose gravel, 145 yards rock.

DREDGING.

Repairs to the dredge were completed so that work was commenced July 8 at Archers Bar, 1 mile below Marias River. Two cuts were made through the shoal on left side of the bar 1,000 feet long, 13,744.79 cubic yards being removed.

The work was considerably delayed by a sudden rise of 4.5 feet and the large amount of drift coming with it.

This work was completed and the dredge moved on July 31 to Churchills Bend (29 miles from Fort Benton). A single cut 1,100 feet long was made, 7,840.7 cubic yards being removed. A stoppage of three days was caused by the breaking of a pinion on the swinging engine.

On August 14 the dredge was moved to Crow Coulee where a single cut 1,200 feet long was made, 9,710.39 cubic yards being removed.

On August 26 the dredge was started for Pinnacle Reef Bar (66 miles from Fort Benton). After much difficulty on account of shoal water at many places, the *Josephine* succeeded in getting the dredge down to La Barge Rock (55 miles from Fort Benton). On account of rocks and the low stage of the river it was impracticable to get the dredge farther down and the orders were to suspend operations for the season.

An attempt was made to dig a basin for a winter harbor, but the rocky bottom prevented a sufficient depth being obtained. She was then pulled out on a high bank just above the mouth of Eagle Creek, one-third mile above La Barge Rock.

QUARRY WORK.

The party of from 12 and 15 men remained in camp at La Barge Rock until September 6, breaking up the bowlders at the foot of the cliff. All of the fallen rock was used and large quantities were blasted from the face and top of the cliff.

The following list shows the amount of rock taken and where delivered: Evans Bar, 282 yards; Fontanelle Bar, 406 yards; Archers Bar, 473 yards; Crow Coulee, 256 yards.

On September 6 the quarry work was closed and the party moved up the river to assist in the dam-building work.

ROCK REMOVAL.

Repairs to the derrick boat were completed so that work was commenced August 15 just below Marias River (21½ miles from Fort Benton).

The boat moved down the river taking out the worst rocks to Iron City Island (94 miles from Fort Benton), which point was reached October 24, when the work was suspended for the season.

The boat was brought back 7 miles to Judith and the party commenced grading the bank to haul out the fleet. Most of the rocks were placed on or near the bank at points from which they were not liable to be carried by ice into the channel again; many of the large rocks were blasted and the larger fragments removed and about half those taken out at Drowned Mans Rapids were dropped in deep water just below.

The following table shows the localities worked and number of rocks removed at each place:

	Rocks removed.
Near Marias River	7
Lower end Archers Island	12
Churchills Bend	3
Near La Barge Rock	3
Near Citadel Bluff	5
2 to 3 miles below Hole-in-the-Wall	9
Near Steamboat Rock	2
Pablo Island	8
Pablo Rapids	35
½ mile above Wolf Island	15
½ mile above Arrow River	6
Near mouth of Arrow River	27
1½ miles below Arrow River	6
2½ to 3½ miles below Arrow River	11
1 mile above Drowned Mans Rapid	8
Drowned Mans Rapid	25
Council Island	18
Upper end Holmes Rapid	1
Holmes Rapid	20
Lower end Holmes Rapid	27
Bend above Iron City Island	3

LAYING UP FLEET.

Search was made along the river for some distance above and below Judith for a good winter harbor, but no place could be found free from danger of damage by ice and it was decided to haul all the boats out on the bank. A place was selected just above the warehouse at Judith and the bank for 120 feet graded to an easy slope.

There were hauled out here the store boat, derrick boat, three 65-foot barges, one 50-foot barge, and three 40-foot barges.

The quarterboat and the small steamer *Josie* were necessarily kept in the river till the last in order to finish the dam in the head of the chute on the opposite side of the river. They were brought over to the Judith side of the river, but before they could be taken down to the incline the running ice gorged on the head of the bar and the water run out so low that they could not reach the incline and they were hauled out on top of the bank about 1,600 feet above the other boats.

The party was disbanded November 21, 1891.

Very respectfully, your obedient servant,

H. C. GOULD.

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Five boats, the largest three of which draw 3½ to 4 feet, loaded, and are of about 300 tons burden, are running on the river, engaged mostly in carrying wheat, live stock, merchandise, flour, and Indian and military supplies between Sioux City, Running Water, Chamberlain, Pierre, Bismarck, Stanton, and Berthold. The fourth boat is of about 50 tons; the fifth one, lately built at Fort Yates, is smaller.

The Benton Transportation Company has material and machinery on hand at Bismarck for a new large boat. A boat of 150 tons is now being built at Sioux City, and the material is on hand for a barge to be run with her in a projected trade next above Sioux City. The *Mary Bennett*, of about 100 tons, heretofore used as a pontoon bridge tender at Sioux City, has been purchased by steamboat people, who expect to run her with a barge in a local jobbing and excursion trade.

The steamboat *Libbie Conger* came from the upper Mississippi River last spring to engage in a contract for river transportation of military supplies from Bismarck and Pierre, but after making one trip to Bismarck was withdrawn, as understood, since the contract was too small and the navigation too difficult for her size and draft. An association of Charles Mix County (S. Dak.) farmers are negotiating for this boat to run between their landings and Sioux City.

The following newspaper dispatches show demands for new river business:

"[Special.]

"CASTALIA, *February 23, 1892.*

"The citizens of Charles Mix County have been holding regular county steamboat meetings for the past 3 months, at which various schemes have been discussed with a view to securing a line of boats on the Missouri River to ply between this point and Sioux City. The interest in the movement has been universal throughout the county, and the only obstacle has been the best way to go at it. * * * At a meeting at Edgerton on last Saturday the whole matter was gone over and the propositions from steamboat companies at St. Louis, Dubuque, and Bismarck considered, also the propositions of gentlemen willing to erect warehouses and buy grain. * * * A company was organized and will be incorporated at once. * * * Warehouses will be erected at two and perhaps three landings, and buyers set at work to work the traffic via the river. The meeting and a short canvass afterwards discloses the fact that there are some 2,000 head of cattle now fattening for the spring market, besides double that number of hogs, and an enormous quantity of wheat and still greater amount of corn." * * *

"[Special.]

"PIERRE, *May 23, 1892.*

"M. T. Wolverton, president of the board of trade of Campbell County, and E. A. Grady, a prominent citizen of the same county, have been in Pierre the past week

for the purpose of getting the people of this city interested in securing a line of steamers to run up and down the river, in which they can ship their produce to market. They state that the people of Campbell and Walworth counties, in South Dakota, and Emmons County, in North Dakota, are now compelled to haul their grain from 40 to 60 miles to market, that being the nearest point to a railroad. Mr. Wolverton, in speaking of the matter, says that in Campbell County alone there is now 100,000 bushels of last year's wheat crop yet unmarketed. The poor roads during the past winter and the long haul have prevented the farmers hauling their grain. He estimates that if a line of steamers were put on Campbell County alone would furnish 250,000 bushels of this year's wheat crop to be transported. The people of Pierre have become interested in the matter and will do what they can to aid the project. It is expected that if the line of steamers are put on to run from Sioux City to Charles Mix County the same steamers could extend their trip up to take in these upper-river counties."

"[Special.]

"PIERRE, *July 13, 1892.*

"Prominent wool-growers of Hughes and Sully counties have contracted with one of the river transportation companies for the carrying of 1,000,000 pounds of wool, which represents this year's clip. The Northwestern Railroad Company refused to make any special rates on the quantity, so the shipment will be made from this point to Sioux City and from there by rail to New York. About $5,000 in freight will be saved by this route."

Other prospective river freights are considerable quantities of wool, lead-silver ore, and possibly coal from Montana; the former two commodities are now transported east by wagon and rail haul, but it is only a question of time when a part at least will go by river. Geological reports state that coal exists in the Judith Basin of Montana similar to that extensively mined in the Great Falls field, and a natural outlet of which is by river from Judith.

Lignite abounds along the river in North Dakota, and the urgent need of cheap fuel at river towns and for steamboats is likely to create some traffic in this coal, notwithstanding its inferior quality.

The completion of the railroad from Rapid City to Port Pierre, about 166 miles, will furnish with the river a cheaper outlet than now existing for the good coal, coke, ores, and building material of the Black Hills. The shortest rail lines from Rapid City to Sioux City and Omaha are 484 and 547 miles; the respective distances, rail and river via Fort Pierre, would be 537 and 672 miles.

The Western Portland Cement Works at Yankton produce a Portland cement of tests equal to those of the imported article, and whose output during 1891 was about 30,000 barrels and is increasing. The material for the Yankton cement—chalkstone and clay—abound in large quantities, and are said to show at places on the river above and below Yankton; the chalk certainly crops out from the river bluffs, and it seems that the cement industry, at least at Yankton, should be extensive, and the cement shipped down the river to Sioux City, Omaha, and other cities.

Settlements along the river are increasing and crowding closely to the reservations, which, between Sioux City and Fort Benton, occupy 1,095 miles of river frontage and generally include the best lands. The transportation of farm and range products on the river between main railroad points should gradually increase; those for 1892 will certainly be larger than for 1891.

The traffic amounts tabulated below do not include ferriage business.

River tonnage between Sioux City and Fort Benton.

[Exclusive of live stock.]

	Tons.
1887	13,961
1888	12,895
1889	16,724
1890	13,326
1891	13,055

Traffic by river reaches.

River reaches.	Package and bulk freight.	Passengers.	Live stock.
1890.			
	Tons.	*No.*	*Head.*
Beween Sioux City and Bismarck	9,735	4,322	2,974
Between Bismarck and Fort Buford	2,467	184	43
Between Fort Buford and Fort Benton	1,124	62	43
1891.			
Between Sioux City and Bismarck	10,410	1,749	4,683
Between Bismarck and Fort Buford	2,645	139	59

STATEMENT OF FRANKLIN COMMERCIAL CLUB, CAMPBELL, SOUTH DAKOTA.

FRANKLIN COMMERCIAL CLUB,
Campbell, S. Dak., April 24, 1892.

DEAR SIR: Our club respectfully calls your attention to the following facts:

(1) We are from 40 to 50 miles from a railway market; consequently it requires all our time in the fall to market our crops, and fall plowing can not be done.

(2) We have a warehouse, but as it is back from the river so far we can not ship our grain through it except at a great loss in handling.

(3) If the river could be so improved near here that the warehouse could be moved to the water's edge, our crops could and would be shipped through it, thereby enabling farmers to get their plowing and other fall work done, which they are now unable to do to a great extent.

(4) Parties have been here who would build a first-class flouring mill if the river were safe to build close to, so that the flour could be shipped out and coal shipped in on the river without too great a cost in handling, and also get water for the engine from the river.

(5) We believe that there is no point on the river where permanent improvements could be made that would benefit a greater number of agriculturists.

We present these facts for your earnest consideration, and hope that you will investigate them thoroughly, as we believe that it is the intention of the Missouri River Commission to do the work where the greatest good will result, and where the people will take advantage of the improvements to better their own condition.

*   *   *   *   *   *   *

Yours respectfully,

FRANKLIN COMMERCIAL CLUB.
M. T. WOLVERTON, *Secretary.*

Capt. C. F. POWELL,
Corps of Engineers.

STATEMENT OF THE MISSOURI RIVER TRANSPORTATION COMPANY.

THE MISSOURI RIVER TRANSPORTATION COMPANY,
PRESIDENT'S OFFICE,
Mandan, N. Dak., May 30, 1892.

SIR: Replying to your favor of 23d, would say: Our Missouri River business between Standing Rock Agency at the south and Fort Berthold on the north promises to be very large this season. The steamer *Abner O'Neal* will probably carry close to 5,000 tons of freight between these points, taking and landing most of the freight at Bismarck and Mandan Landing. The farmers north of the Northern Pacific Railroad have been greatly favored with crops, which are to be transported by boat to the railroad. They are also buying merchandise liberally. Present season will probably be the best for several years.

Respectfully,

JOHN M. TURNER,
Prest.

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

STATEMENT OF JUDITH MERCANTILE COMPANY.

OFFICE OF JUDITH MERCANTILE COMPANY,
Judith Landing, Montana, June 20, 1892.

DEAR SIR: In reply to your favor of the 7th instant, which has just come to hand, will say that there ought to be offered for shipment down the Missouri River during the season of navigation of 1893 and 1894 from this point at least 2,000,000 pounds of wool, besides, say, 5,000 tons of lead-silver ore for the smelter at Omaha. This amount of freight would be shipped from *this point* if the river was in good condition for boats and the rates the same as from railroad points 40 miles north. I should estimate the increase in imports of merchandise for 1891 over 1890 into the Judith country by rail to be at least 25 or 30 per cent. This year it will be much larger, say 50 per cent. With the Missouri River in fair condition steamboats could have for shipment from this place and some few places below, like Rocky Point, at least 2,000,000 pounds of wool *this season.*

We will actually cross here on the ferry for shipment east via rail, and which properly should go via river, this season, about as follows: Mutton sheep, 75,000 head; wool, 500,000 pounds; merchandise, from the east to Judith Basin points by rail, say 1,000 tons; besides there will be at least 10,000 head of beef steers cross the river here for shipment to Chicago.

In conclusion will say that if the sheep business continues to increase as reasonable to suppose it will, there should be tributary to Missouri River points, and that properly should go via boats, the summer of 1894, say from Judith to mouth of Milk River, 5,000,000 pounds of wool. This may look big to you, but think it a fair estimate, as you of course know that it is a large country and all wool from 60 miles south and 25 miles north of the Missouri River between points mentioned would, with rates being equal, go by boats.

Will be glad to give you any information at any time.

Yours, very respectfully,

G. R. NORRIS.

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

STATEMENT OF RAPID CITY BOARD OF TRADE.

OFFICE OF RAPID CITY BOARD OF TRADE,
Rapid City, S. Dak., June 29, 1892.

DEAR SIR: The answer to your letter of June 7 has been delayed in order to get exact figures. Finding this impossible where figures of exports from the Black Hills could not be obtained, opinions and close estimates by persons acquainted with the various lines have been procured and are herewith given.

The Rapid City, Missouri River and St. Paul Railroad from this city to Fort Pierre will, it is expected, be completed and in operation by May 1, 1893. The Dakota, Wyoming and Missouri River Railroad, on which work has been going forward since last September, running westwardly from this city through the richest mineral districts of the Hills, connecting with the Burlington and Missouri River Road and its spurs to the different producing camps, thence on to the coal and oil fields of the Western Hills, will be completed by December 1 next.

The largest shipments out of the Hills in the past has been in the cattle line. Last year the Fremont, Elkhorn and Missouri Valley Road carried out 90,000 head, or about 4,500 car loads, to Omaha, Sioux City, and other points. Many thousand head were also driven to Missouri River and other points and shipped out by other roads. The Rapid City, Missouri River and St. Paul Road across the reservation will obtain eight-tenths of this trade at once.

Some, but not much, export trade has been done in the lumber line. All the hills and immediate surrounding country is supplied with all timber and lumber used. Better shipping facilities will naturally increase this trade.

Regarding extent of coal fields which within a few months will be tributary to Rapid City, and the product of which will be shipped through here eastwardly and by river if it can be done, you are probably informed. One field from which shipments will be made so soon as transportation facilities are provided is about 20 by 17 miles. Regarding the quality of the coal, I can say that it is decidedly superior to the average Iowa coal with which I am acquainted. I have seen some, probably the best, Illinois coal, and consider our coal superior to it. It has been coked and tested for smelting purposes and can be profitably coked and used in smelting.

One class of trade which has not yet been developed to any extent, owing in a great degree to the poor transportation facilities, high rates of freight, etc., is in the

building-material line. Even with present disadvantages some brick, stone, lime, stucco, etc., has been and is being shipped to Omaha and other points. With good and cheap transportation facilities an immense trade in these articles will naturally spring up. This owing to the fact, which has been clearly demonstrated on a number of occasions, that we have as good and better building stone than Omaha, Sioux City, and other Nebraska and Iowa points send from 1,000 to 2,500 miles to obtain. The fire brick manufactured here is used in the locomotives on the Fremont, Elkhorn and Missouri Valley Railroad, the Deadwood and Rapid City smelters and chlorination works, and at other works requiring a superior article. The demand for them has always, so far, exceeded the supply. We also have as fine brick-building clays as are found anywhere in the United States. Our deposits of gypsum, limestone, etc., are of the best quality and found in inexhaustible quantity.

Wheat of the best quality is shipped from here to Omaha and other points. The quantity shipped is gradually increasing, and will continue to increase, as more land will constantly be put under cultivation.

The Hills have been shipping gold and silver ores to the smelters at Omaha, Kansas City, Aurora, and other points. The shipments have increased greatly during the past year, and the extent to which such shipments may be increased is simply a question of rates and transportation facilities.

Trusting that this reply may prove satisfactory,

Yours, respectfully,

JOHN BECAN RYAN,
Secretary.

Capt. CHAS. F. POWELL, U. S. A.

RIVER SURVEY NOTES AND DATA.

DESCRIPTIVE NOTES OF MISSOURI RIVER AND ADJACENT COUNTRY FROM WOLF POINT, MONTANA, TO GRINNELLS LANDING, NORTH DAKOTA, 215 MILES. BY MR. F. W. LIGHTNER, CHIEF OF SURVEY PARTY OVER THAT REACH, 1891.

The immediate valley of the Missouri River from Wolf Point to Culbertson, Mont., is from 3 to 5 miles wide. From Culbertson to a few miles above Fort Buford the valley narrows down to about 1 mile in width. From Fort Buford to Grinnells Landing, N. Dak., the valley regains its former width of about 4 miles.

Through this valley the bed of the river winds, rebounding from one bluff to the other. There are thus formed a succession of points, more or less regular, projecting first from one side and then from another, and fitting into each other like cogs.

With but very few exceptions these points are all heavily covered with a most dense growth of cottonwood timber and underbrush, broken with clear patches, especially back towards the bluffs, where the land becomes more elevated and trees give place to grass, sagebrush, etc.

The banks of the river are of a sandy, light character, and easily washed and cut away when struck by the current.

This cutting action of the river, however, takes place seldom at any other time than when the water is unusually high, as in the spring.

This cutting of the banks throws many large trees into the current, which soon settle, with their roots at the bottom, and their tops pointing down stream, and, as a rule, appearing above the surface.

* * * * * * *

The whole length of this part of the river is greatly troubled with these snags. Some of the bends are so full of them that it is a matter of some danger and great difficulty for a steamer to wend her way through.

The banks, as a rule, are low, being from 10 to 15 feet high; but where the river approaches the bluffs they gradually increase in height to as high as 40, 50, and 60 feet.

Whenever the river strikes the bluffs a supply of rock or loose bowlders can generally be found, washed out by the slow action of the current on the face of the bluff.

The bluffs are themselves stable and suffer but little cutting, and that only in the highest water.

At low water the river is very full of, and cut up by, low sand bars of varying sizes. The presence of these bars is the cause of the poor channel at certain places on the river, for, the water being carried off by numerous passages, no single one is left of sufficient depth to float a good-sized steamer.

The north or left-hand side of the valley going down has by all odds the greater

points, and about three-fourths of the entire bottom lands. What few settlers there are and all the towns are on this north side of the river.

The bottoms are of a fertile soil, and this only needs sufficient and regular waterings to enable it to take on the character of an agricultural country. The country, however, fares badly in its lack of rains at the growing seasons, and relying entirely on nature for water supplies, the farmers can expect but one good crop out of three or four sowings.

A good system of irrigation would undoubtedly develop these lands into a great agricultural region; but at present the few settlers are too poor to attempt irrigation with any system, and are content to raise a few fresh vegetables for their own use, watering their little gardens by hand.

To be convinced that this land needs only sufficient water to make it fruitful, we have only to look at the results where irrigation has been tried. At Fort Buford there is a large post garden, which not only amply supplies the post and its dependents with vegetables, but even exports them to neighboring towns and cities. The season is too short up here to make much of a success of late garden truck, such as tomatoes, melons, etc.; but no garden ever raised better and larger potatoes, cabbages, etc., than are here raised at Buford every year with the help of the water pumped from the river by a small hoisting engine.

From Wolf Point down to the Big Muddy River, which extent is all Indian reservation and about 40 miles long, the bottom is very wide and peopled by Indians, some of whom are very successful with their gardens. One especially, a half-breed, raised, besides garden truck, 15 or 20 acres of as fine wheat and oats as one would expect to find in Manitoba or the Red River Valley.

Further down the river, between Williston, N. Dak., and Grinnell, N. Dak., many more white settlers are found, as this is beyond the Indian and military reservation lines. These settlers depend less on cattle-raising than those above and are very successful and prosperous in their farms and glad and able to sell grain and vegetables of the best quality at reasonable prices.

Some 20 or 30 miles above Grinnell lignite coal is found in the hills and cliffs. In numerous places it is smoldering, as is evidenced from the heavy smoke hanging over the hills when the air is calm.

Along the bottom from Wolf Point to Big Muddy several very fine wells and springs are fostered and used by the Indians. Below Williston the settlers back from the river obtain their water from wells.

The whole country from Wolf Point to Grinnell is a very fine grazing one and occupied by vast herds of cattle and sheep, whose owners are only too glad to discourage all attempts at the breaking up and settling of the country.

The settlers along the river, especially those below Williston, feel the need or would appreciate the advantages of a steamer to ply back and forth and carry their increasing products to market and their supplies back home.

The farmers below Williston have to haul their products from 15 to 30 miles to the towns along the Great Northern Railroad, while a navigable river and steamers would greatly facilitate the transportation of products to Williston and encourage their production.

DESCRIPTIVE NOTES OF MISSOURI RIVER AND ADJACENT COUNTRY FROM GRINNELL LANDING TO CANNON BALL, NORTH DAKOTA, 254 MILES, BY MR. G. W. WOOD, CHIEF OF SURVEY PARTY OVER THAT REACH, 1891.

The Missouri River from Grinnell Landing to Cannon Ball flows between bank that are of a soft, sandy nature, which yield readily and rapidly to the strong currents of the river when brought against them during a high stage of water.

As a result of this caving of banks, large trees with wide-spreading roots and branches are swept into the current, and after a short journey are brought to a standstill by dragging on the bottom or by meeting some other obstacle. This obstruction quickly gathers other drift and soon an accumulation is formed sufficient to turn the strong current from its former course and in such a direction as to strike an opposite bank and thus repeat the operation above mentioned. Bars are formed about these snags, separating the volume of water; the banks are eroded, and before many seasons the river is widened to such an extent that the water, spreading out over this area, necessarily becomes shallow and sluggish and unable to hold in suspension sediment brought down from above. New bars are formed, and thus the operation continues until the river is full of bars and the water is divided into so many streams that none have sufficient depth for good navigation.

As the river wanders along down the valley it occasionally runs up against the high bluffs which inclose it on either side, and after following it for a short distance rebounds again to the opposite bluff.

These bluffs are generally composed of a hard clay, with an occasional ledge of sandstone, and in many places gravel and bowlders, so that caving takes place very

slowly. Yet it does wash away and at times large slices of the bluff slide towards the river, but for all practicable purposes the erosion is so slow that such banks may be considered as permanent.

At many places the bluffs show evidence of having been at some remote period the banks of the river, although now far from it.

The old river bed has been filled level with the surrounding bottom land and is now covered with a heavy growth of timber.

At other places the river after forming a bend, has gradually worked itself across the point, cutting off the bend and leaving quite a body of water, afterwards known as a lake (such as Mandan Lake and Painted Woods Lake).

It is not improbable that this restless stream has in time past covered the greater portion of the entire valley.

Between Grinnell Landing and Bismarck there are about twenty-five wide places in the river, full of bars, making navigation rather difficult, especially at a low stage of water. At other places the river is comparatively free from obstructions of all kinds, with a very good channel.

Between Bismarck and the mouth of Cannon Ball River there are only two places where the river is so full of bars as to make navigation at a low stage of water difficult, although the river is very crooked and has numerous large and abrupt bends; one, especially, opposite Stewartsdale post-office, where it is about one-half mile across the bend and 6 miles around. There are, however, quite a good many snags obstructing the channel, which otherwise would be very good, although narrow.

The improvement of these reaches would not be a difficult or an expensive matter.

Wing dams built from the shores above and placed at the proper angle to the current would deflect and concentrate the water at the desired point and scour out a suitable channel. Most of the bars are low and flat and of a sandy and silty nature, easily washed away.

Piling and brush in abundance can be obtained in close proximity to most of these reaches and stone suitable for ballast in the vicinity of nearly all.

The valley through which this river flows is an exceedingly fertile one, and were it not for the long dry spells, which sometimes continue for one or more seasons, very large crops would always be assured.

Wheat, potatoes, and barley are the principal crops and most garden vegetables do well, but the season seems to be too short for corn, although a variety known as "squaw corn," a short, stumpy growth with small ears, grows prolifically.

In several places large tracts of this fertile land are so situated that they are capable of being irrigated by water from the creeks flowing into the Missouri.

As a grazing country it has no superior. The short, nutritious buffalo grass, good at all seasons of the year and most always obtainable, excepting in case of a very heavy snowfall, is a most excellent food for stock of all kinds, while the dense growth of timber and underbrush along the bottoms furnishes a good protection from the cutting winds and cold of winter.

Many of the settlers who left that country within the last few years—because of the failure of their crops, due to dry seasons—and went to other States, have returned after learning that no country is exempt from crop failures at times, either from drought or from other causes equally as disastrous, and that this section possesses many advantages not found elsewhere.

They have also learned not to depend on crops alone, but to devote a good portion of their time and capital to stock-raising, which is sure to bring them good returns if properly managed.

Fuel in abundance is to be had for the hauling, either wood from the heavy growth along the river or lignite coal, which frequently crops out along the bluffs and river banks in such profusion as to cause visitors to wonder why nothing more than local attention is paid to such stores of what seems to be a most excellent fuel.

It is claimed by some, who profess to have experimented with it as a steam producer, that it is of no use, but it seems reasonable to suppose that any substance which burns as freely and is such a success for heating purposes as this coal must, with proper appliances, be a good fuel for engines of all descriptions.

DESCRIPTIVE NOTES OF MISSOURI RIVER AND ADJACENT COUNTRY FROM CANNON BALL, NORTH DAKOTA, TO CAMPBELL, SOUTH DAKOTA, BY MR F. M. TOWAR, CHIEF OF SURVEY PARTY OVER THAT REACH, 1892.

The valley of the Missouri River from the mouth of the Cannon Ball River, North Dakota, to Campbell Post-Office, S. Dak., a distance by river of 62 miles, is from 1 to 2 miles wide between the bluffs.

The river, with a width of from 800 to 1,200 feet, winds back and forth, striking the bluffs on either side at points from 2 to 5 miles apart,

Along this part of the river are a number of small rivers or creeks emptying into the Missouri, each having a valley of its own from one-half to 1 mile wide, the bottoms of which are very fertile.

The water in these creeks is not of sufficient volume for purposes of irrigation, the Cannon Ball River being the only river in this locality which discharges any considerable volume of water into the Missouri at low water.

The bottom lands of this portion of the Missouri River are not very much cultivated, although on the bottoms at the foot of the bluffs and between them and the trees are extensive strips of meadow lands, on which great quantities of wild hay are cut annually.

The west side of the river over the whole distance above described is Indian reservation, and small fields are cultivated by the Indians at frequent intervals.

The valley over this portion of the river may be described under two heads that are distinctly different. From Cannon Ball River to Fort Yates under one head, and from Fort Yates to Campbell under the other. The former stretch seems to be composed of more unstable material, the soil being of a silty character, cutting so easily that the channel of the river is constantly changing from one side to the other. For instance, when Fort Yates was built in 1876 the channel of the river ran along the foot of the bluffs on which the post is located; now it is 1¼ miles distant, washing the bluffs on the opposite side. On account of this constant and frequent shifting of the river there is very little large timber, the foliage being too small, consisting of willows and small cottonwood. On the latter stretch the bottoms are covered, sometimes to the foot of the bluffs, with a dense growth of cottonwood, box elder, ash, and elm.

Although the river bottom between Cannon Ball River and Campbell is not occupied very much, the table-land on top of the bluffs is settled quite thickly; the sod houses of the settlers are in view in every direction; roads are built along all the township lines, with crossroads almost every mile, and in appearance there seems to be as much farming as in some of the river counties of Iowa and Nebraska.

In making the trip from the river at Campbell post-office to the railroad (40 miles) I was surprised to learn the extent of cultivation along the river and back from it for 20 miles. On each side of the road, almost continuously, were fields of wheat, flax, and corn, while on every hand one could see small bands of cattle and horses and occasionally a flock of sheep.

The farmers are very much encouraged in South Dakota this year, for, having had good crops last year, with such bright prospects for the coming harvest of 1892, they feel that their farms are secure, for two good crops in succession in this region always pay for the farm.

Distances, from river survey.

[Continued from page 2235, report for 1891.]

Places.	Midway between banks.	Channel line.	Places.	Midway between banks.	Channel line.
	Miles.	*Miles.*		*Miles.*	*Miles.*
Fort Benton Bridge	0.0	0.0	Little Missouri	670.2	702.4
Wolf Point Agency	382.5	394.9	Berthold Agency, 1891	695.7	729.9
Poplar Creek Agency	413.1	427.1	Old Fort Stevenson	710.9	745.9
Devils Elbow	453.3	470.4	Stanton	734.5	770.7
Big Muddy Creek	459.7	477.2	Washburn	755.5	792.4
Yellowstone River	503.7	524.7	Rock Haven	787.9	828.9
Fort Buford	506.1	527.4	Mandan	791.4	832.7
Williston	540.8	564.7	Bismarck Bridge	793.3	834.7
Grinnells Landing	594.4	621.0	Fort Lincoln	798.1	839.9
White Earth River	609.8	638.5	Apple Creek	805.6	847.9
Knife River	620.5	650.1	Old Fort Rice	835.6	879.8
Indian Creek	635.4	665.9	Cannon Ball River	841.4	886.0

Dates of ice closings and openings on the Missouri River, above Sioux City, Iowa.

[Continued and extended from page 3392 report for 1890; previous tables on page 1349, report for 1883, and page 2325, report for 1888.]

Locality.	1890–'91.		1891–'92.	
	Closing.	Opening.	Closing.	Opening.
Townsend, Mont			Dec. 24	Feb. 24.
Fort Benton, Mont	Feb. 1	Mar. 20	Dec. 26 Feb. 15	Feb. 7. Feb. 24.
Judith, Mont			Nov. 16 Dec. 25	Nov. 26. Mar. 10.
Wolf Point, Mont			Nov. 12	Mar. 29 to Apr. 1.
Fort Buford, N. Dak	Dec. 4	Mar. 29	Nov. 16	Apr. 4.
Bismarck, N. Dak	Dec. 3	Apr. 3-4	Nov. 15	Apr. 3 to 5.
Cannon Ball River, N. Dak			Nov. 18	Mar. 30 to Apr. 2.
Pierre, S. Dak				Mar. 28.
Chamberlain, S. Dak				Mar. 27 to 28.
Sioux City, Iowa	Jan. 4	Mar. 31	Nov. 25 Dec. 25	Dec. 13. Mar. 5 to 25.

NOTE.—The single dates of openings are the times when the ice first moves out; generally the ice runs for several days afterward. The expressions like "April 3 to 5" indicate that the ice first breaks up on the first date and runs more or less until the last date, after which the river would be open for navigation.

LOCATION OF BENCH MARKS, PRIMARY LEVELING, 1885–1892, FORT BENTON, MONTANA, TO CANNON BALL, NORTH DAKOTA.

The bench mark generally used and, unless otherwise noted, is a stone 18 by 18 by 4 inches buried flatwise from 3 to 3½ feet below the surface of the ground, surmounted by a 5-inch iron gas pipe 4 feet long to the top of its cap.

A hole one-half inch in diameter at the middle of the top and dressed surface of the stone marks the level point on that surface; around the hole the letters "U. S. B. M." are cut in the stone.

The cap is fastened to the top of the pipe by a bolt and nut, and bears the inscription "Missouri River Commission" around the outside of the disk and the letters "U. S. B. M." at the middle.

$\frac{1}{1}$ On right bank, about 100 feet northwest of brick house of C. L. Smith and 1,000 feet south of iron bridge at Fort Benton. Plotted on chart 1.

$\frac{1}{2}$ On left bank, in southeast corner of court-house yard, Fort Benton. Plotted on chart 1.

Benton Gauge: Top of stone water table on southeast corner of T. C. Power & Bro.'s brick store, at Fort Benton, Mont.

$\frac{2}{1}$ On right bank, 1¾ miles below Fort Benton Bridge, at foot of bluffs, and 900 feet below where river first strikes the right bank bluffs. Plotted on chart 1.

$\frac{2}{2}$ On left bank, 1¾ miles below Fort Benton Bridge, 1,200 feet north from river and 500 feet south from foot of bluffs. Plotted on chart 1.

$\frac{3}{1}$ On the right bank, 900 feet below mouth of Shonkin Creek, 250 feet from river and 100 feet from wagon road. Plotted on chart 1.

$\frac{3}{2}$ On left bank, 500 feet from river and 550 feet northeast from H. Brinkman's house. Plotted on chart 2.

$\frac{4}{1}$ On right bank, 1¾ miles below Evans Bend, 200 feet from river and 200 feet west of wagon road. Plotted on chart 2.

$\frac{4}{2}$ On left bank, 1¾ miles below Evans Bend, 700 feet from river and 100 feet east of house of John Lippard. Plotted on chart 2.

$\frac{5}{1}$ On right bank, 2,000 feet southeast from Henry O'Hanlon's house, at foot of bluffs, 900 feet from river. Plotted on chart 2.

$\frac{5}{2}$ On left bank, opposite B. M. $\frac{5}{1}$, behind point of timber and 400 feet from river bank. Plotted on chart 2.

$\frac{6}{1}$ On right bank, opposite head of Brulé Bar, 550 feet from river and 1,200 feet below creek at end of bluffs. Plotted on chart 3.

$\frac{6}{2}$ On left bank, opposite Brulé Bar, at foot of bluffs, 200 feet from river bank. Plotted on chart 3.

$\frac{7}{1}$ On right bank, 2,000 feet northeast from stone quarry below Senieurs Reach, 500 feet from river at foot of bluffs. Plotted on chart 3.

$\frac{7}{2}$ On left bank, about a mile below Senieurs Reach near foot of bluffs, 700 feet from river bank. Plotted on chart 3.

$\frac{8}{1}$ On right bank, 2 miles below Rowes Bayou, ½ mile below lower end of Black Bluffs and 250 feet from river. Plotted on chart 4.

$\frac{8}{2}$ On left bank, opposite B. M. $\frac{8}{1}$ and 500 feet from river. Plotted on chart 4.

$\frac{9}{1}$ On right bank, ½ mile below and opposite mouth of Marias River, 100 feet from river bank. Plotted on chart 4.

$^{9}_{2}$ On left bank, nearly ½ mile north from mouth of Marias River, 650 feet from bank of the latter and 300 feet from foot of bluffs. Plotted on chart 4.

$^{10}_{1}$ On right bank, ¼ mile below foot of Archer Island and 200 feet from river bank. Plotted on chart 4.

$^{10}_{2}$ On left bank, ⅜ mile below Archers Island, 1,300 feet from river bank and 600 feet from foot of bluffs. Plotted on chart 5.

$^{11}_{1}$ On right bank, ½ mile below John Churchill's ranch, 300 feet from river bank and opposite head of island. Plotted on chart 5.

$^{11}_{2}$ On left bank, opposite B. M. $^{11}_{1}$, 750 feet from river, near foot of bluffs. Plotted on chart 5.

$^{12}_{1}$ On right bank, ½ mile below Charles Lippard's ranch, 150 feet from river bank. Plotted on chart 5.

$^{12}_{2}$ On left bank, ½ mile below Charles Lippard's ranch, at foot of bluffs and 400 feet from river. Plotted on chart 5.

$^{13}_{1}$ On right bank, about 450 feet northeast from ranch of C. W. Price, 650 feet from river bank. Plotted on chart 5.

$^{13}_{2}$ On left bank, opposite B. M. $^{13}_{1}$, exact position not determined by either triangulation or topography.

$^{14}_{1}$ On right bank, about ¼ mile below foot of Crow Coulee Bar, 600 feet from river bank, on right bank of small creek. Plotted on chart 6.

$^{14}_{2}$ On left bank, opposite Crow Coulee Bar, 1,300 feet northeast from river bank. Plotted on chart 6.

$^{15}_{1}$ On right bank, about 2⅜ miles by river below Crow Coulee Bar, 500 feet above head of small island and 400 feet east from river bank. Plotted on chart 6.

$^{15}_{2}$ On left bank, about 2¼ miles below Crow Coulee Bar, 200 feet from river bank. Plotted on chart 6.

$^{16}_{1}$ On right bank, about ½ mile above head of Boggs Island, 275 feet from river bank. Plotted on chart 6.

$^{16}_{2}$ On left bank, about ½ mile above head of Boggs Island, and 100 feet from river bank. Plotted on chart 6.

$^{17}_{1}$ On right bank, ¾ mile above Coal Banks Landing, 1,500 feet from river bank, 500 feet from foot of bluffs. Plotted on chart 7.

$^{17}_{2}$ On left bank, ⅜ mile above Coal Banks Landing, 250 feet from river bank and 100 feet east of wagon road. Plotted on chart 7.

$^{18}_{1}$ On right bank, about ⅜ mile below Pugsley & Bros. ranch, 400 feet from river bank and 250 feet from foot of bluffs. Plotted on chart 7.

$^{18}_{2}$ On left bank, opposite B. M. $^{18}_{1}$, at foot of bluff. Plotted on chart 7.

$^{19}_{1}$ On right bank, 1 mile below mouth of Little Sandy Creek, 900 feet west from river bank behind timber and 500 feet from foot of bluffs. Plotted on chart 8.

$^{19}_{2}$ On left bank, 1 mile below Little Sandy Creek, 300 feet from river bank and 300 feet from left bank of small creek. Plotted on chart 8.

$^{20}_{1}$ On right bank, about ¾ mile below Haystack Butte, 75 feet from river. Plotted on chart 9.

$^{20}_{2}$ On left bank, ½ mile below Haystack Butte, 200 feet from river bank. Plotted on charts 8 and 9.

$^{21}_{1}$ On right bank, about ¾ mile above Labarge Rock, 100 feet from river bank. Plotted on chart 9.

$^{21}_{2}$ On left bank, 2,000 feet above mouth of Eagle Creek, 125 feet from river bank. Plotted on chart 9.

$^{22}_{1}$ On right bank, 2 miles above Kipp Rapids, 200 feet from river bank. Plotted on chart 10.

$^{22}_{2}$ On left bank, opposite B. M. $^{22}_{1}$, 150 feet from river. Plotted on chart 10.

$^{23}_{1}$ On right bank, just above Kipp Rapids, 400 feet from river bank. Plotted on chart 10.

$^{23}_{2}$ On left bank, near Kipp Rapids, and 750 feet northwest of Eagle Rock. Plotted on chart 10.

$^{24}_{1}$ On right bank, 1,700 feet above Cathedral Rock, 100 feet from river bank. Plotted on both charts 10 and 11.

$^{24}_{2}$ On left bank, opposite B. M. $^{24}_{1}$, 100 feet from river bank. Plotted on charts 10 and 11.

$^{25}_{1}$ On right bank, near and due north from Hole-in-the-Wall, 350 feet from river bank. Plotted on chart 11.

$^{25}_{2}$ On left bank, opposite B. M. $^{25}_{1}$ and 150 feet from river bank. Plotted on chart 11.

$^{26}_{1}$ On right bank, 3 miles below Hole-in-the-Wall, 200 feet above mouth of small creek and 50 feet from river bank. Plotted on chart 11.

$^{26}_{2}$ On left bank, opposite the last-named bench, 250 feet from river bank. Plotted on charts 11 and 12.

$^{27}_{1}$ On right bank, 2 miles above Pablo Island, 175 feet from river bank. Plotted on chart 12.

$^{27}_{2}$ On left bank, opposite last-named bench and 150 feet from river bank. Plotted on chart 12.

$^{28}_{1}$ On right bank, at Pablo Rapids, 100 feet from river bank. Plotted on charts 12 and 13.

$^{28}_{2}$ On left bank, opposite B. M. $^{28}_{1}$, 50 feet from edge of first bench of land. Plotted on charts 12 and 13.

$^{29}_{1}$ On right bank, 1 mile below Wolf Island, 500 feet from river bank. Plotted on chart 13.

$^{29}_{2}$ On left bank, opposite last-named bench, 250 feet from river bank. Plotted on chart 13.

$^{30}_{1}$ On right bank, 1½ miles below mouth of Arrow River, 100 feet from river bank. Plotted on chart 14.

$^{30}_{2}$ On left bank, opposite the last-named, just above high perpendicular bluff and 75 feet from river.

$^{31}_{1}$ On right bank, 3½ miles below the mouth of Arrow River, 850 feet above mouth of small creek and 175 feet from river bank.

$^{31}_{2}$ On left bank, opposite the last-named bench and 200 feet from river bank. Plotted on chart 14.

$^{32}_{1}$ On right bank, ½ mile above Drowned Man Rapids, 550 feet from river bank, on bench 100 feet from left bank of small creek. Plotted on chart 15.

$^{32}_{2}$ On left bank, opposite last-named and 300 feet from river bank. Plotted on chart 15.

$^{33}_{1}$ On left bank, in northwest corner of J. R. Norris's front yard, at Judith Landing. Plotted on chart 15.

$^{33}_{2}$ On left bank, opposite mouth of Judith River, 800 feet from river bank. Plotted on chart 15.

$^{34}_{1}$ On right bank, a little above foot of Council Island, near foot of slope, 200 feet from river bank. Plotted on chart 16.

$^{34}_{2}$ On left bank, opposite Dog Island, 500 feet from river bank. Plotted on chart 16.

$^{35}_{1}$ On right bank, opposite foot of Holmes Council Island, 100 feet from river bank. Plotted on chart 16.

$^{35}_{2}$ On left bank, opposite last-named bench, 50 feet from river. Plotted on chart 16.

$^{36}_{1}$ On right bank, opposite foot of Iron City Island, 600 feet from river bank. Plotted on chart 17.

$^{36}_{2}$ On left bank, 400 feet below foot of Iron City Island, on high bank 100 feet from river. Plotted on chart 17.

$^{37}_{1}$ On right bank, ½ mile above Gallatin Rapids, 100 feet from river bank. Plotted on chart 17.

$^{37}_{2}$ On left bank, opposite last-named bench, 150 feet from river. Plotted on chart 17.

$^{38}_{1}$ On right bank, ½ mile above Little Dog Creek, 50 feet from river bank. Plotted on charts 17 and 18.

$^{38}_{2}$ On left bank, about ½ mile above mouth of Little Dog Creek, 75 feet from river bank. Plotted on charts 17 and 18.

$^{39}_{1}$ On right bank, ½ mile below foot of Dauphin Rapids, 200 feet from river bank. Plotted on chart 18.

$^{39}_{2}$ On left bank, opposite last-named bench and 160 feet from river bank. Plotted on chart 18.

$^{40}_{1}$ On right bank, 2⅝ miles above Lone Pine Rapids, 100 feet from river. Plotted on chart 19.

$^{40}_{2}$ On left bank, opposite B. M. $^{40}_{1}$. Plotted on chart 19.

$^{41}_{1}$ On right bank, below foot of Castle Bluff Rapids, 100 feet from river. Plotted on chart 19.

$^{41}_{2}$ On left bank, at foot of Castle Bluff Rapids, 250 feet from river. Plotted on chart 19.

$^{42}_{1}$ On right bank, about 3½ miles below Castle Bluff Rapids, on high bank, 175 feet from river and 50 feet above mouth of small creek. Plotted on chart 20.

$^{42}_{2}$ On left bank, opposite B. M. $^{42}_{1}$, 200 feet from river. Plotted on chart 20.

$^{43}_{1}$ On right bank, 2½ miles below Birds Rapids, 100 feet from river. Plotted on chart 21.

$^{43}_{2}$ On left bank, opposite B. M. $^{43}_{1}$, 150 feet from river and 350 feet from foot of bluffs. Plotted on chart 21.

$^{44}_{1}$ On right bank, ¾ mile below Sturgeon Island, 350 feet from river. Plotted on chart 21.

$^{44}_{2}$ On left bank, ¾ mile below foot of Sturgeon Island, 150 feet from river. Plotted on chart 21.

$^{45}_{1}$ On right bank, about 800 feet above mouth of Snake Creek, 175 feet from river. Plotted on chart 22.

$\frac{45}{2}$ On left bank, about ¼ mile above mouth of Snake Creek, 100 feet from river bank. Plotted on chart 22.

$\frac{46}{1}$ On right bank, about ¾ mile above Cow Creek, 90 feet from river. Plotted on chart 22.

$\frac{46}{2}$ On left bank, about ¾ mile above Cow Creek, near foot of bluffs, 150 feet below end of willows. Plotted on chart 22.

$\frac{47}{1}$ On right bank, ¾ mile below foot of Cow Island, 225 feet from river and 500 feet below where river leaves bluffs. Plotted on chart 23.

$\frac{47}{2}$ On left bank, 1 mile below foot of Cow Island, 300 feet from river. Plotted on Chart 23.

$\frac{48}{1}$ On right bank, at Dexter Chute, 150 feet from river. Plotted on chart 23.

$\frac{48}{2}$ On left bank, at Dexter Chute, 200 feet from river bank. Plotted on chart 23.

$\frac{49}{1}$ On right bank, 2 miles above head of Grand Island, 200 feet from river. Plotted on chart 24.

$\frac{49}{2}$ On left bank, 2 miles above head of Grand Island, opposite B. M. $\frac{49}{1}$. Plotted on chart 24.

$\frac{50}{1}$ On right bank, at head of Grand Island, 300 feet from river. Plotted on chart 24.

$\frac{50}{2}$ On left bank, at head of Grand Island, 200 feet from river bank and 300 feet northeast from north end of dam. Plotted on chart 24.

$\frac{51}{1}$ On right bank, about 1 mile below foot of Hammond Island, on bench behind sagebrush. Plotted on chart 25.

$\frac{51}{2}$ On left bank, about ⅝ mile below foot of Hammond Island, 600 feet from river bank. Plotted on chart 25.

$\frac{52}{1}$ On right bank, opposite the upper end of the lower of the Two Calf Islands, 150 feet from river bank. Plotted on chart 25.

$\frac{52}{2}$ On left bank, opposite $\frac{52}{1}$. Position not accurately determined.

$\frac{53}{1}$ On right bank, about 2¼ miles above Armel Creek, opposite Grays Point, 150 feet back from willows. Plotted on charts 25 and 26.

$\frac{53}{2}$ On left bank, 3⅛ miles above mouth of Armel Creek, about ½ mile above Grays Point, 450 feet from river and near foot of bluffs. Plotted on chart 26.

$\frac{54}{1}$ On right bank, 250 feet west from mouth of Armel Creek, 400 feet southeast from point of bluff. Plotted on chart 26.

$\frac{54}{2}$ On left bank, one-half mile above mouth of Armel Creek, 500 feet from river. Plotted on chart 26.

$\frac{55}{1}$ On right bank, 1½ miles below foot of Armel Island, 600 feet east from upper end of willows and 175 feet south from edge of willows. Plotted on chart 27.

$\frac{55}{2}$ On left bank, 1¼ miles below foot of Armel Island, in bottom back of willows. 150 feet north from and 1,600 west from where willows reach foot of bluff. Plotted on chart 27.

$\frac{56}{1}$ On right bank, about ½ mile above mouth of Warm Spring Creek, near edge of timber, 1,150 feet northwest from high butte. Plotted on chart 27.

$\frac{56}{2}$ On left bank, 1,000 feet west from mouth of Warm Spring Creek and 300 feet from river bank. Plotted on chart 27.

$\frac{57}{1}$ On right bank, about 1¼ miles below Broadwater Landing, ½ mile above mouth of Rock Creek and 225 feet from river bank. Plotted on chart 28.

$\frac{57}{2}$ On left bank, about a mile above Rocky Point, 800 feet from river bank. Plotted on chart 28.

$\frac{58}{1}$ On right bank, opposite small island about 3½ miles below Rocky Point. Plotted on chart 28.

$\frac{58}{2}$ On left bank, about 4 miles below Rocky Point, 700 feet from river bank, behind timber, and about 600 feet southeast from high point of ridge. Plotted on charts 28 and 29.

$\frac{59}{1}$ On right bank, near Carroll Landing, 1,500 feet from river, in mouth of small coulée. Plotted on chart 29.

$\frac{59}{2}$ On left bank, near foot of bluff, behind timber, opposite Carroll Landing. Plotted on chart 29.

$\frac{60}{1}$ On right bank, about 2 miles above head of Ryan Island, 1,050 feet from river and about 500 feet south from edge of willows. Plotted on chart 29.

$\frac{60}{2}$ On left bank, 1¾ miles above head of Ryan Island, 275 feet from river bank. Plotted on chart 29.

$\frac{61}{1}$ On right bank, at foot of Ryan Island, 100 feet above creek, 600 feet from river bank. Plotted on chart 30.

$\frac{61}{2}$ On left bank, directly opposite B. M. $\frac{61}{1}$. Plotted on chart 30.

$\frac{62}{1}$ On right bank, 3½ miles below foot of Ryan Island, in middle of bend, and 300 feet from river. Plotted on chart 30.

$\frac{62}{2}$ On left bank, directly opposite B. M. $\frac{62}{1}$. Plotted on chart 30.

$\frac{63}{1}$ On right bank, opposite $\frac{63}{2}$, near foot of bluffs. Position not accurately determined.

$\frac{63}{2}$ On left bank, 1 mile below Circle Bar cattle ranch, at foot of bluffs, and 1,500 feet above where river strikes bench. Plotted on chart 31.

$\frac{64}{1}$ On right bank, directly opposite Hawley Island cut-off, at foot of bluffs. Plotted on chart 31.

$\frac{64}{2}$ On left bank, at foot of point of bluffs, just below Hawley Island cut-off. Plotted on chart 31.

$\frac{65}{1}$ On right bank, 4 miles below lower end of Hawley Island cut-off, in large valley, 500 feet from river bank. Plotted on chart 32.

$\frac{65}{2}$ On left bank, opposite $\frac{65}{1}$, 800 feet from foot of bluffs. Plotted on chart 32.

$\frac{66}{1}$ On right bank, 4 miles by river above B. M. $\frac{67}{1}$, 1,000 feet above where river strikes bluffs, at foot of bluffs. Plotted on chart 33.

$\frac{66}{2}$ On left bank, directly opposite B. M. $\frac{66}{1}$ and at foot of bluffs. Plotted on chart 33.

$\frac{67}{1}$ On right bank of river 3¼ miles along foot of bluffs, above B. M. $\frac{68}{1}$, about 4,000 feet below where river leaves right bluffs. Plotted on charts 33 and 34.

$\frac{67}{2}$ On left bank, directly opposite B. M. $\frac{67}{1}$, at foot of bluffs, on foothill. Plotted on chart 33.

$\frac{68}{1}$ On right bank, 3¾ miles above Musselshell River, 500 feet from river bank and 500 feet below where river begins to leave right bluffs, on top of bench. Plotted on chart 34.

$\frac{68}{2}$ On left bank, ½ mile above B. M. $\frac{68}{1}$ and 800 feet from river. Plotted on chart 34.

$\frac{69}{1}$ On right bank, 1½ miles above mouth of Musselshell River, at foot of bench and 1,500 feet below where river leaves right bluff. Plotted on chart 35.

$\frac{69}{2}$ On left bank, 1½ miles above mouth of Musselshell River, ¼ mile from river bank and 1,500 feet from foot of bluffs. Plotted on chart 35.

$\frac{70}{1}$ On right bank, even with point of bluff on upper side of Squaw Creek Valley and 1,000 feet from foot of bluffs. Plotted on chart 35.

$\frac{70}{2}$ On left bank, directly across the Missouri Valley from B. M. $\frac{70}{1}$, about 1,000 feet above where river strikes bluffs. Plotted on chart 35.

$\frac{71}{1}$ On right bank, 2 miles below Squaw Creek, 300 feet from river. Plotted on chart 36.

$\frac{71}{2}$ On left bank, opposite and about 1,000 feet below B. M. $\frac{71}{1}$ and close to foot of bluffs. Plotted on chart 36.

$\frac{72}{1}$ On right bank, 1½ miles above head of Hornet Island. Plotted on chart 36.

$\frac{72}{2}$ On left bank, ¾ mile above head of Hornet Island, near foot of bluffs, about 1,000 feet above where river cuts left bluffs. Plotted on chart 36.

$\frac{73}{1}$ On right bank, ¾ mile below foot of Hornet Island, near top of bench. Plotted on chart 37.

$\frac{73}{2}$ On left bank, 1 mile below Hornet Island, 600 feet from river and 1,000 feet above where the river strikes bluffs. Plotted on chart 37.

$\frac{74}{1}$ On right bank, opposite B. M. $\frac{74}{2}$. No elevation has ever been obtained of this B. M., neither has its position been determined.

$\frac{74}{2}$ On left bank, 4 miles above Elk Island, close to foot of bluffs and 3,000 feet below where river leaves left bluff. Plotted on chart 37.

$\frac{75}{1}$ On right bank, 1,000 feet above head of Elk Island, 200 feet from river. Plotted on chart 38.

$\frac{75}{2}$ On left bank, opposite head of Elk Island, exact position not determined.

$\frac{76}{1}$ On right bank, 5 miles by river above Trovers Point, about 1,000 feet above where the river strikes bench. Plotted on chart 38.

$\frac{76}{2}$ On left bank, 1 mile above B. M. $\frac{76}{1}$, ½ mile from river, 2,700 feet from East Base, just south of Trovers Point base line. Plotted on chart 39.

$\frac{77}{1}$ On right bank, 5½ miles by river below Trovers Point, 1,000 feet from river, 1,500 feet above small creek. Plotted on chart 40.

$\frac{77}{2}$ On left bank, directly opposite B. M. $\frac{77}{1}$, 1,000 feet above where river cuts left bluffs, 300 feet from river. Plotted on chart 40.

$\frac{78}{1}$ On right bank, ¾ mile above Buffalo Shoal, 600 feet from river. Plotted on chart 43.

$\frac{78}{2}$ On left bank, directly across from B. M. $\frac{78}{1}$, 300 feet from river. Plotted on chart 42.

$\frac{79}{1}$ On right bank, 7½ miles above Round Butte, 600 feet from river and 1 mile above small creek. Plotted on chart 43.

$\frac{79}{2}$ On left bank, directly across from B. M. $\frac{79}{1}$ and 400 feet back from a high-cut bench on river. Plotted on chart 43.

$\frac{80}{1}$ On right bank, 1½ miles above Little Snow Creek, 200 feet from river. Plotted on chart 46.

$\frac{80}{2}$ On left bank, ½ mile above $\frac{80}{1}$, 1,300 feet below where river strikes bench, 150 feet from top of bench. Plotted on chart 46.

$\frac{81}{1}$ On right bank, 2 miles below Hell Creek, 300 feet from river bank on bench. Plotted on chart 47.

$\frac{81}{2}$ On left bank, 2½ miles below Hell Creek, 600 feet below head of island and 800 feet from river back of narrow strip of timber. Plotted on chart 48.

$\frac{83}{1}$ On right bank, 5 miles by river above Little Dry Fork, 1,000 feet from river on bench, back of timber. Plotted on chart 50.

$\frac{83}{2}$ On left bank, 1 mile above B. M. $\frac{83}{1}$ at foot of bluffs, 1½ miles below where river strikes bluff, 1,600 feet from river. Plotted on chart 50.

$\frac{84}{1}$ On right bank, 1,600 feet below Little Dry Fork and 250 feet from river. Plotted on chart 50.

$\frac{84}{2}$ On left bank, 2¾ miles above Catamount Creek, 1,000 feet from river. Plotted on chart 50.

$\frac{85}{1}$ On right bank, 4 miles by river below Catamount Creek, just below where river strikes right bluffs, 400 feet from river bank. Plotted on chart 52.

$\frac{85}{2}$ On left bank, 1⅜ miles below B. M. $\frac{85}{1}$ and 400 feet above where river strikes prairie bottom on left bank. Plotted on chart 52.

$\frac{86}{1}$ On right bank, 4 miles along foot of bluffs below B. M. $\frac{85}{1}$, 1,000 feet above where river cuts bluffs and 500 feet from river. Plotted on chart 52.

$\frac{86}{2}$ On left bank, 1½ miles above B. M. $\frac{86}{1}$, at foot of bluffs and 1,800 feet below where river leaves bluffs. Plotted on chart 52.

$\frac{87}{1}$ On right bank, 2 miles above Old Fort Peck on bottom, 500 feet from river. Plotted on chart 54.

$\frac{87}{2}$ On left bank, ½ mile above Old Fort Peck and 3 miles above Dry Fork, 800 feet from river. Plotted on chart 54.

$\frac{88}{1}$ On right bank, 1½ miles below Dry Fork, 500 feet from river. Plotted on chart 54.

$\frac{89}{1}$ On right bank, directly across river from Galpin, on top of bench. Plotted on chart 55.

$\frac{89}{2}$ On left bank, at Galpin 1,000 feet from river bank, 900 feet back from Joe Batch's house. Plotted on chart 55.

$\frac{90}{1}$ On right bank, 5½ miles by river above mouth of Milk River on top of bench 500 feet from river and just above beginning of young cottonwood and willows. Plotted on chart 57.

$\frac{91}{1}$ On right bank, opposite and 1 mile below mouth of Milk River, 1,650 feet from river. Plotted on chart 57.

$\frac{91}{2}$ On left bank, directly across river from B. M. $\frac{91}{1}$ and 1,800 feet from shore. Plotted on chart 57.

$\frac{92}{1}$ On right bank, 2½ miles downstream from B. M. $\frac{92}{2}$, 600 feet from river, in sharp bend. Plotted on chart 58.

$\frac{92}{2}$ On left bank, 1,100 feet from river, 2½ miles south from Bridge No. 325, Great Northern Railroad. Plotted on charts 58 and 59.

$\frac{93}{1}$ On right bank, 3 miles below Box Elder Creek, 900 feet from river bank and 1,800 feet from where bench leaves the river. Plotted on chart 59.

$\frac{93}{2}$ On left bank, opposite Lennox station on Great Northern Railroad, 500 feet from river bank, on top of high bench. Plotted on chart 60.

$\frac{94}{1}$ On right bank, first bend above Elk River where river strikes bluffs, on foothill, 480 feet from river. Plotted on chart 60.

$\frac{94}{2}$ On left bank, 2½ miles below B. M. $\frac{94}{1}$, 320 feet from river bank and ½ mile below foot of timber. Plotted on chart 61.

$\frac{95}{1}$ On right bank, 2 miles below mouth of Elk River, 540 feet from river bank just where the river makes a sharp bend to left. Plotted on chart 62.

$\frac{95}{2}$ On left bank, 2 miles by river below B. M. $\frac{95}{1}$, 1,100 feet from river bank at sharp bend. Plotted on chart 62.

$\frac{96}{1}$ On right bank, 1,040 feet from river bank, ½ mile below mouth of Sand Creek, and 2 miles by river above B. M. $\frac{95}{2}$. Plotted on chart 62.

$\frac{96}{2}$ On left bank, at first bend above Wolf Point, 900 feet from river, and about 500 feet from edge of timber. Plotted on chart 63.

$\frac{97}{1}$ On right bank, 1½ miles above Wolf Point, 600 feet from river. Plotted on chart 63.

$\frac{97}{2}$ On left bank, at Wolf Point 660 feet from landing, 230 feet west of sawmill and on line with west side of the road leading up to the traders' store. Plotted on chart 63.

$\frac{98}{2}$ On left bank, 2½ miles east of Wolf Point railway station, 665 feet west of railway bridge, and 75 feet north of wagon road. Plotted on chart 64.

$\frac{99}{2}$ On left bank, 400 feet south and 75 feet east of section house at Macon station Great Northern Railroad, and 50 feet south of wagon road.

$\frac{100}{2}$ On left bank, about 2¾ miles west of Chelsea station, 300 feet south of railroad, 75 feet north of wagon road, and 175 feet west of where wagon road descends into low bottom.

$\frac{101}{2}$ On left bank, 3,100 feet southeast from Chelsea station, 300 feet north of the east and west wagon road and 1,100 feet west of north and south wagon road.

$\frac{102}{2}$ On left bank, about 5 miles west of Poplar Creek railroad station, 790 feet south of Great Northern Railroad and 1,350 feet from river. Plotted on chart 66.

$\frac{103}{2}$ On left bank, 2½ miles west of the railway bridge across Poplar Creek, 300 feet south of track and about 650 feet from edge of timber.

$\frac{104}{2}$ On left bank, 750 feet north and 150 feet east of Great Northern railroad station at Poplar Creek.

$\frac{195}{2}$ On left bank, about 2¼ miles east of Poplar Creek station and 400 feet south of Great Northern Railroad track. Plotted on chart 68.

$\frac{196}{2}$ On left bank, about 5¾ miles east of Poplar Creek railroad station, 1,000 feet from river on high bench, 350 feet west of road running up coulée.

$\frac{197}{2}$ On left bank, 9 miles east of Poplar Creek railroad station and 240 feet south of the wagon road running west from the Indian village Po-gun-ta-sa-pa, and 650 feet from foot of bluff. Plotted on chart 70.

$\frac{198}{2}$ On left bank, about 11¼ miles east of Poplar Creek railroad station, near edge of bluff, 1,500 feet northeast from mouth of a coulée, 100 feet southeast and across wagon road from small house. Plotted on chart 71.

$\frac{199}{2}$ On left bank, 4 miles west of Calis railroad station, Great Northern Railroad, 1 mile east of water tank, 440 feet from track. Plotted on chart 71.

$\frac{110}{2}$ On left bank, about a mile west from Calis station, 1,100 feet south of Great Northern Railroad track. Plotted on chart 71.

$\frac{111}{2}$ On left bank, 2¾ miles east from Calis, 1,300 feet from railroad bridge No. 232, 325 feet south of Great Northern Railroad track. Plotted on chart 72.

$\frac{112}{2}$ On left bank, 2¼ miles west from Blair station, Great Northern Railroad, about 1¼ miles west of railroad bridge No. 225 and 240 feet north of track.

$\frac{113}{2}$ On left bank, 3,800 feet east of Blair station, 135 feet from track. Plotted on chart 73.

$\frac{114}{2}$ On left bank, nearly 2 miles west of Culbertson station, Great Northern Railroad, 210 feet north of track, opposite center of curve. Plotted on chart 74.

$\frac{115}{2}$ On left bank, 1¼ miles southeast of Culbertson station, Great Northern Railroad, 3,000 feet east of Standing Buffalo's ranch, 200 feet north of wagon road. Plotted on chart 75.

$\frac{116}{2}$ On left bank, about 3¼ miles southeast from Standing Buffalo's ranch. Plotted on chart 75.

$\frac{117}{2}$ On left bank, at second cut bluff on left bank of river below Standing Buffalo's ranch, 225 feet from river and 950 feet east from where bluffs leave the river.

$\frac{118}{2}$ On left bank, 6 miles by river above the cut-off at Little Muddy Creek, 1,850 feet southeast from mouth of large coulee and 130 feet from foot of bluff. Plotted on chart 77.

$\frac{119}{2}$ On left bank, at point of bluff above mouth of Little Muddy Creek, 175 feet from right bank of creek, 200 feet north from edge of bench. Plotted on chart 77.

$\frac{120}{2}$ On left bank, 3 miles west of the Great Northern Railway station at Willows, 2,050 feet southeast from the railroad bridge just north of Little Muddy and 100 feet south of track. Plotted on chart 78.

$\frac{121}{2}$ On left bank, 80 feet from foot of bluff and 1,100 feet north from section house at Willows railway station.

$\frac{122}{2}$ On left bank, 2¾ miles east of railway station at Willows, 100 feet south of railroad track and opposite the curve. Plotted on chart 79.

$\frac{123}{2}$ On left bank, 2¼ miles west of Buford railway station, Great Northern Railroad, 550 feet west from water tank, 800 feet north from windmill, and 125 feet south of track. Plotted on chart 79.

$\frac{124}{2}$ On left bank, 540 feet west from northwest corner and in line with north end of warehouse at Fort Buford. Plotted on chart 80.

Fort Buford gauge. At Fort Buford Landing, 12 feet from edge of bank directly opposite the quartermaster's buildings, is a three-fourths-inch iron rod, driven into the ground 10 inches below the surface, protected by an iron pipe.

$\frac{125}{2}$ On left bank, about 2¼ miles east of Buford railroad station, 2,950 feet south of railroad track and 1,800 feet west of small, dry creek. Plotted on chart 80.

$\frac{126}{2}$ On left bank, 5¼ miles east of Buford station, 3,200 feet southeast from railroad bridge No. 163.

$\frac{127}{2}$ On left bank, just west of railroad station, Trenton, on the Great Northern Railroad, 800 feet northeast from railroad bridge No. 159, 600 feet from west end of siding, and 40 feet north of wagon road.

$\frac{128}{2}$ On left bank, 2¾ miles east of Trenton railway station, 225 feet north from railroad bridge No. 153. Plotted on chart 82.

$\frac{129}{2}$ On left bank, ¼ mile east of Jones Cut, 300 feet east of railway bridge No. 144, and 75 feet south of track.

$\frac{130}{2}$ On left bank, 3 miles west of Great Northern Railway station, Williston, ¾ mile northeast from railroad bridge No. 136, on top of low bluff and 600 feet north from railroad track. Plotted on chart 83.

$\frac{131}{2}$ On left bank, 550 feet northeast from northwest corner of railroad station at Williston. Plotted on chart 83.

$\frac{132}{2}$ On left bank, 3 miles southeast from Williston, 950 feet north from the river at mouth of dry creek and 1,350 feet nearly southeast of a small house.

$\frac{133}{2}$ On left bank, at first point where river strikes bluff on left bank below Williston, 400 feet from river, and 125 feet from foot of bluff. Plotted on chart 84.

$\frac{134}{2}$ On left bank, ½ mile above second point where river strikes left bank bluffs below Williston, 160 feet north of wagon road at Ehorst's ranch. Plotted on chart 84.

$\frac{135}{2}$ On left bank, 1¼ miles above third point where river strikes left bank bluffs below Williston and ¼ mile northwest from bend of high bank at edge of timber. Plotted on chart 85.

$\frac{136}{2}$ On left bank, ½ mile above Harris's ranch, 500 feet from foot of bluffs, on line with north fence and opposite mouth of coulee. Plotted on chart 85.

$\frac{137}{2}$ On left bank, 3 miles below Harris's ranch, ½ mile from river, back of timber and ¾ mile below where timber begins. Plotted on chart 86.

$\frac{138}{2}$ On left bank, at third point where river cuts left bluffs above Nesson post-office, 12½ miles by river above the latter place, 250 feet from river, in mouth of double coulee just above beginning of willows. Plotted on chart 86.

$\frac{139}{2}$ On left bank, 2 miles above David Gamarch's ranch, 200 feet from river, ½ mile below point of timber and brush. Plotted on chart 87.

$\frac{140}{2}$ On left bank, 1¾ miles below David Gamarch's ranch, on second bench, upper side of a coulee, lower end of a strip of grass land and ¾ mile from river. Plotted on chart 87.

$\frac{141}{2}$ On left bank, ½ mile southeast of Nesson post-office, on second bench, ½ mile from river and 1 mile below where river cuts left bluff. Plotted on chart 88.

$\frac{142}{2}$ On left bank, 3½ miles below Nesson post-office, 1,000 feet southeast along foot of bluffs from Edward Richards's house; most easily reached from point opposite Clark Creek; from this point a strip of grass land runs to the B. M. Plotted on chart 88.

$\frac{143}{2}$ On left bank, 1¼ miles above Grinnells Landing, 1,200 feet southwest of Carey Bros.' house, 300 feet south of wagon road, 2,900 feet from river. Plotted on chart 89.

$\frac{144}{1}$ On right bank, 2¾ miles below Grinnells Landing, on mound 1,750 feet from river and nearly south from mouth of small coulée. Plotted on chart 89.

$\frac{145}{1}$ On right bank, about 1¾ miles below mouth of Beaver Creek, 1,700 feet from river. Plotted on chart 90.

$\frac{145}{2}$ On left bank, about 5¾ miles below mouth of Beaver Creek, on bench 700 feet from river. Plotted on chart 90.

$\frac{146}{2}$ On left bank, ½ mile directly back from mouth of White Earth River, 2½ miles below Ed. Hall's ranch, 875 feet from wagon road. Plotted on chart 90.

$\frac{147}{2}$ On left bank, 2½ miles above Indian village of Crow Flies High, 200 feet from wagon road. Plotted on chart 92.

$\frac{148}{2}$ On left bank, ½ mile below mouth of Little Knife River, 525 feet from Missouri River. Plotted on chart 92.

$\frac{149}{2}$ On left bank, about 7½ miles below mouth of Little Knife River, 1½ miles above creek on right bank, and 800 feet from river. Plotted on chart 93.

$\frac{150}{2}$ On left bank, 2½ miles above mouth of Indian Creek, on bench 1,950 feet from river, 1,000 feet southwest from large mound. Plotted on chart 94.

$\frac{151}{2}$ On left bank, about 5 miles below mouth of Indian Creek, 700 feet from river, on high bench about 75 feet back from edge and 250 feet southeast from point of high, sharp ridge. Plotted on chart 95.

$\frac{152}{2}$ On left bank, just below Fort Manenry Bend, opposite large coulee and high butte on right bank, 1,450 feet from river, 180 feet from corner, and on the line with fence at northeast end of field. Plotted on chart 96.

$\frac{153}{2}$ On left bank, at the upper end of "The Slide," on high point 150 feet southeast from wagon road. Plotted on chart 97.

$\frac{154}{2}$ On left bank, 1,200 feet above north of Rising Water Creek, 450 feet from river and 150 feet from log house. Plotted on chart 97.

$\frac{155}{2}$ On left bank, 2½ miles below mouth of Rising Water Creek, opposite large island, 4,500 feet from river, on high bench, 550 feet south from where wagon road leaves bottom. Plotted on chart 98.

$\frac{156}{2}$ On left bank, 1¾ miles above mouth of Little Missouri River, 3,400 feet from Missouri River, on point of high ridge, 400 feet from edge of timber. Plotted on chart 99.

$\frac{157}{2}$ On left bank, about 1 mile northwest of Sacred Heart Mission, 700 feet north of log house and 800 feet southeast from forks of wagon road. Plotted on chart 99.

$\frac{158}{2}$ On left bank, about 8 miles below mouth of Little Missouri River, 950 feet from river and 550 feet north from northwest corner of fence. Plotted on chart 100.

$\frac{159}{2}$ On left bank, about 10½ miles by road above Fort Berthold, on bench near foot of bluffs, about 1,000 feet above where road goes up on top of bluffs, and about 30 feet from wagon road. Plotted on chart 101.

$\frac{160}{2}$ On left bank, about 7½ miles by road above Fort Berthold, 450 feet from river on round knoll. Plotted on chart 101.

$\frac{161}{2}$ On left bank, about 6½ miles by river above Fort Berthold, on edge of bench in bottom behind timber, opposite and ¾ mile below mouth of Little Beaver Creek. Plotted on chart 101.

$\frac{162}{2}$ On left bank, at Fort Berthold Mission, in corner of lane 300 feet west of mission schoolhouse on wagon road. Plotted on chart 102.

$\frac{163}{2}$ On left bank, on a ridge about ½ mile below John Wayle's, the last house on reservation, and about 100 feet from road towards river. Plotted on chart 103.

$\frac{164}{2}$ On left bank, about 3 miles down river from B. M. $\frac{162}{2}$, on a small knoll about halfway between wagon road and old telegraph line. Plotted on chart 103.

$\frac{165}{2}$ On left bank, on a ridge overlooking Old Fort Stevenson and about 2 miles above it, about 150 feet from road which runs along near edge of high bank. Plotted on chart 104.

$\frac{166}{2}$ On left bank, on ridge about 1 mile below Old Fort Stevenson, about 300 feet from road which runs along edge of bench. Plotted on chart 105.

$\frac{167}{2}$ On left bank, about 2¾ miles above the town of Coal Harbor, on high bench behind lower end of timber, 2,450 feet above Snake Creek. Plotted on chart 105.

$\frac{168}{2}$ (Secondary △ Robinson) On left bank, about a mile south of the town of Coal Harbor, on high knoll, on ground set apart for cemetery for above town. Plotted on chart 105.

$\frac{169}{2}$ On left bank, about 3½ miles below B. M. $\frac{167}{2}$, on a small knoll, at foot of bluffs, and is just below a road that turns into the woods after running along on top of bluff. Plotted on chart 106.

$\frac{170}{2}$ On left bank, on edge of bank, about 15 feet from road toward river, and 500 feet below R. R. Jones's house at Hancock, N. Dak. Plotted on chart 106.

$\frac{171}{2}$ On left bank, 4 miles downstream from B. M. $\frac{169}{2}$, on a knoll 1,500 feet from river, and opposite middle of a small strip of timber. Plotted on chart 107.

$\frac{172}{2}$ On left bank, on edge of bench near house of P. O. Gradin, 4 miles below B. M. $\frac{170}{2}$, directly opposite the town of Stanton, N. Dak. Plotted on chart 107.

$\frac{173}{2}$ On left bank, 5 miles below Stanton, on high bank, just above where river strikes bank behind lower point of willows. Plotted on chart 108.

$\frac{174}{2}$ On left bank, on a flat-topped knoll, about 600 feet back from edge of willows, and about one-half mile upstream from J. C. Burgum's house. Plotted on chart 108.

$\frac{175}{2}$ On left bank, about 6¼ miles above Washburn, N. Dak., 700 feet from river, behind small fringe of trees on high bank. Plotted on chart 109.

$\frac{176}{2}$ On left bank, about 200 feet back of road, 350 feet from river, 2 miles above Washburn. Plotted on chart 110.

$\frac{177}{2}$ On left bank, on knoll about 2 miles below Washburn, 200 feet back from road and 1,600 feet above Turtle Creek Bridge. Plotted on chart 110.

$\frac{178}{2}$ On left bank, 2 miles north of Falconer post-office, on ridge 400 feet east of wagon road, in line of telegraph poles. Plotted on chart 111.

$\frac{179}{2}$ On left bank, about 1½ miles below Falconer post-office, on a knoll back of woods; a road runs into the woods nearly opposite B. M. Plotted on chart 111.

$\frac{180}{2}$ On left bank, one-half mile below Mr. Adams's house, on edge of bank nearly opposite his lower wood yard. Plotted on chart 112.

$\frac{181}{2}$ On left bank, 1 mile above Wogansport, N. Dak., 75 feet from cut bluff, near foot of willow bar, about one-fourth mile above a small house standing on edge of bluff. Plotted on chart 113.

$\frac{182}{2}$ On left bank, about 2¾ miles below Wogansport, ⅜ mile above bridge across small dry creek, on high knoll east of wagon road, 750 feet southeast of house of Lewis Lawson. Plotted on chart 113.

$\frac{183}{2}$ On left bank, about 3½ miles above mouth of Square Butte Creek, on high point in front of butte, 1,400 feet from river, 750 feet east of wagon road. Plotted on chart 114.

$\frac{184}{1}$ On right bank, at Rock Haven, 200 feet above mouth of couleé, 350 feet from river, about 400 feet from log house, on west side of wire fence. Plotted on chart 114.

$\frac{184}{2}$ On left bank, nearly opposite Rock Haven, on southwest slope of bluff, 850 feet south-southeast from house of E. N. Sperry, near Burnt Creek Bridge. Plotted on chart 114.

Mandan: At Mandan, N. Dak., on stone foundation to March Bros'. grocery store, under iron pillar on east side of door on southeast corner of store. This is the most easterly building of any size in town.

$\frac{185}{2}$ On left bank 1¼ miles above Bismarck Bridge, 500 feet northwest from residence of Wm. O. Ward. Plotted on chart 115.

Railroad track: On right bank, top of rail in front of water tank, Mandan, N. Dak.

Bismarck Bridge: On pier 1, top of east bolt on south side of pier. This is one of the bolts that anchor the iron work of the bridge to the pier. Plotted on chart 116.

Bismarck Brewery: A cross (×) cut in foundation stone of south brick building of brewery at its northwest corner. The letters U. S. are cut in the brick above cross. Plotted on chart 116.

$\frac{186}{2}$ On left bank, about 1 mile below Bismarck Bridge, 850 feet from river on bench north of railroad track, 150 feet from track. Plotted on chart 116.

$\frac{187}{1}$ On right bank, 1,500 feet above Fort Abraham Lincoln, 1,700 feet south from mouth of Heart River, 100 feet from river. Plotted on chart 116.

$\frac{188}{1}$ On right bank, about 3½ miles by road below Fort Lincoln, about 1,400 feet back from high cut bank of river, 700 feet from wagon road and northwest from Riverside Ranch. Plotted on chart 117.

$\frac{189}{2}$ On left bank, on top of cut bluff, ¼ mile below mouth of Apple Creek, 125 feet from edge of bluff, on line of wire fence. Plotted on chart 117.

$\frac{190}{2}$ On left bank, about 6¼ miles below mouth of Apple Creek, ½ mile north from river and 50 feet west of house of C. Farrand. Plotted on chart 118.

$\frac{191}{2}$ On left bank, in first large bend to north above Glencoe post-office, N. Dak., on ridge 3,400 from river, 350 east of forks of road. Plotted on chart 118.

$\frac{192}{1}$ On right bank, 6¼ miles above Glencoe post-office, on knoll 1,500 feet back from upper end of high cut bank at river, and 3,000 feet north of Smith & Perkins sheep ranch. Plotted on chart 119.

$\frac{193}{2}$ On left bank, 1 mile northwest of Glencoe post-office, midway between two wagon roads. Plotted on chart 119.

$\frac{194}{1}$ On right bank, 4 miles below Glencoe post-office, 800 feet from river and south side of the lower of two small couleés. Plotted on chart 120.

$\frac{195}{2}$ On left bank, about 2½ miles above Old Fort Rice, 250 feet from river and 300 feet west of wagon road. Plotted on chart 120.

$\frac{196}{1}$ On right bank, one-half mile below Old Fort Rice, 375 feet from river, 600 feet north from house of John B. Marsh. Plotted on chart 120.

$\frac{197}{2}$ On left bank, 2¼ miles above the mouth of Cannon Ball River, ½ mile from river. Plotted on chart 121.

Elevations and geographical positions of bench marks, primary leveling, 1885-1892, Fort Benton, Mont., to Cannon Ball, North Dakota. *

[The datum plane is approximately 77.4 feet below mean tide near New York. Azimuths and distances are from bench 1 to bench 2 of same line.]

Bench mark.	Elevation.	Latitude.			Longitude.			Azimuth.			Distance.
	Feet.	°	′	″	°	′	″	°	′	″	Feet.
$\frac{1}{1}$	2,704.001	47	48	45.31	110	39	47.28	161	04	00	1,499.4
$\frac{1}{2}$	2,700.000	47	48	59.31	110	40	09.06				
Benton gauge	2,704.560										
$\frac{2}{1}$	2,692.349	47	49	35.65	110	37	51.60	148	00	00	2,703.2
$\frac{2}{2}$	2,693.232	47	49	58.29	110	38	12.74				
$\frac{3}{1}$	2,690.904	47	50	25.10	110	35	46.13	164	17	00	3,004.8
$\frac{3}{2}$	2,681.793	47	50	53.61	110	35	58.08				
$\frac{4}{1}$	2,679.816	47	51	53.92	110	35	02.79	75	49	30	2,749.4
$\frac{4}{2}$	2,691.585	47	51	47.27	110	35	41.92				
$\frac{5}{1}$	2,668.002	47	51	35.03	110	33	24.24	214	11	40	2,061.9
$\frac{5}{2}$	2,676.754	47	51	51.86	110	33	07.20				
$\frac{6}{1}$	2,657.884	47	52	21.45	110	29	50.45	113	52	50	2,116.6
$\frac{6}{2}$	2,659.821	47	52	29.91	110	30	18.82				
$\frac{7}{1}$	2,652.459	47	53	11.76	110	27	30.81	134	52	20	2,178.4
$\frac{7}{2}$	2,653.312	47	53	26.96	110	27	53.50				
$\frac{8}{1}$	2,644.647	47	54	43.05	110	29	10.59	17	33	20	1,592.7
$\frac{8}{2}$	2,639.177	47	54	28.03	110	29	17.62				
$\frac{9}{1}$	2,636.962	47	55	53.45	110	27	57.34	112	58	30	2,700.0
$\frac{9}{2}$	2,638.308	47	56	03.86	110	28	33.84				
$\frac{10}{1}$	2,633.131	47	56	53.03	110	25	17.53	131	42	00	2,248.8
$\frac{10}{2}$	2,641.202	47	57	07.80	110	25	42.19				
$\frac{11}{1}$	2,620.041	47	56	47.46	110	28	41.49	201	53	50	2,150.0
$\frac{11}{2}$	2,628.826	47	57	07.15	110	23	30.13				
$\frac{12}{1}$	2,623.767	47	57	48.32	110	22	04.57	98	29	10	1,778.3
$\frac{12}{2}$	2,616.985	47	57	50.96	110	22	30.39				
$\frac{13}{1}$	2,615.749	47	59	04.43	110	21	05.00				
$\frac{13}{2}$	2,613.082										
$\frac{14}{1}$	2,625.820	47	58	58.54	110	19	21.70	178	59	00	2,677.4
$\frac{14}{2}$	2,624.563	47	59	24.97	110	19	22.37				
$\frac{15}{1}$	2,610.510	48	00	25.64	110	18	44.88	72	12	05	1,617.4
$\frac{15}{2}$	2,605.554	48	00	20.76	110	19	07.57				
$\frac{16}{1}$	2,602.862	48	01	03.54	110	17	10.26	203	16	00	1,100.0
$\frac{16}{2}$	2,604.346	48	01	13.54	110	17	03.87				
$\frac{17}{1}$	2,603.649	48	01	18.83	110	13	46.78	146	22	30	3,130.4
$\frac{17}{2}$	2,601.905	48	01	44.56	110	14	12.29				
$\frac{18}{1}$	2,595.017	48	02	16.42	110	10	09.61	180	19	30	2,100.9
$\frac{18}{2}$	2,588.050	48	02	37.16	110	10	09.43				
$\frac{19}{1}$	2,580.595	48	00	52.81	110	07	32.07	84	25	00	1,918.6
$\frac{19}{2}$	2,580.882	48	00	54.65	110	07	03.99				

* The positions of the benches were determined from the tertiary triangulation in connection with the topography of the river survey, based upon a secondary triangulation between river bluffs.

The elevations of the benches were determined by a duplicated line of primary levels, checked by the ordinary levels of the topographic party.

The benches from $\frac{1}{1}$ to $\frac{76}{2}$ were placed in 1885, and their positions and elevations determined in 1889 and 1890, and ones from $\frac{77}{1}$ to $\frac{97}{1}$ placed in September and October, 1890, under the direction of the Missouri River Commission.

The benches from $\frac{97}{2}$, near Wolf Point, Mont., to $\frac{197}{2}$, near Cannonball, N. Dak., were placed and their positions and elevations determined in June to November, 1891, and in April and May, 1892; the elevations of benches $\frac{77}{1}$ to $\frac{97}{1}$ determined in 1891, and the computations of positions of benches made by assistant engineer F. M. Towar and Mr. C. A. Swift, in 1892, under the direction of Capt. C. F. Powell, Corps of Engineers.

Elevations and georaphical positions of bench marks, primary leveling, 1885–1892, Fort Benton, Montana, to Cannon Ball, North Dakota—Continued.

[The datum plane is approximately 77.4 feet below mean tide near New York. Azimuths and distances are from bench 1 to bench 2 of same line.]

Bench mark.	Elevation.	Latitude.			Longitude.			Azimuth.			Distance.
	Feet.	°	′	″	°	′	″	°	′	″	Feet.
$\frac{20}{1}$	2,585.115	47	57	49.29	110	05	46.70	207	27	30	1,113.7
$\frac{20}{2}$	2,595.681	47	57	58.93	110	05	39.31				
$\frac{21}{1}$	2,569.767	47	55	12.31	110	03	21.24	264	02	00	902.1
$\frac{21}{2}$	2,573.209	47	55	13.24	110	03	08.10				
$\frac{22}{1}$	2,585.546	47	53	17.27	110	03	50.07	95	36	20	1,007.8
$\frac{22}{2}$	2,581.478	47	53	16.30	110	03	35.35				
$\frac{23}{1}$	2,567.619	47	51	51.94	110	04	02.51	310	23	47	1,438.6
$\frac{23}{2}$	2,579.728	47	51	42.74	110	03	46.43				
$\frac{24}{1}$	2,569.052	47	50	07.70	110	04	29.98	272	46	30	1,995.9
$\frac{24}{2}$	2,565.682	47	50	07.21	110	04	14.19				
$\frac{25}{1}$	2,560.571	47	48	58.53	110	02	45.80	203	26	00	1,222.9
$\frac{25}{2}$	2,571.450	47	49	09.60	110	02	38.71				
$\frac{26}{1}$	2,555.769	47	47	42.25	109	59	17.97	242	35	00	971.9
$\frac{26}{2}$	2,542.301	47	47	46.68	109	59	05.33				
$\frac{27}{1}$	2,543.390	47	46	19.10	109	56	27.75	224	26	00	1,054.0
$\frac{27}{2}$	2,541.724	47	46	26.58	109	56	17.34				
$\frac{28}{1}$	2,533.012	47	45	38.21	109	53	26.95	250	53	00	1,282.3
$\frac{28}{2}$	2,545.865	47	45	42.20	109	53	09.14				
$\frac{29}{1}$	2,532.927	47	43	22.82	109	51	59.49	250	13	00	1,473.0
$\frac{29}{2}$	2,521.225	47	43	27.65	109	51	38.94				
$\frac{30}{1}$	2,514.617	47	42	40.04	109	47	58.52	160	18	30	814.1
$\frac{30}{2}$	2,517.690	47	42	47.21	109	48	02.54				
$\frac{31}{1}$	2,507.060	47	42	20.38	109	45	34.37	212	23	30	841.6
$\frac{31}{2}$	2,523.893	47	42	27.41	109	45	27.77				
$\frac{32}{1}$	2,511.175	47	42	47.73	109	41	49.55	124	38	30	1,431.1
$\frac{32}{2}$	2,522.905	47	42	55.76	109	42	06.74				
$\frac{33}{1}$	2,488.279	47	44	03.92	109	38	06.27	112	45	30	3,382.4
$\frac{33}{2}$	2,488.941	47	44	16.83	109	38	51.86				
$\frac{34}{1}$	2,501.149	47	44	33.74	109	35	09.21	179	08	40	2,811.9
$\frac{34}{2}$	2,501.074	47	45	01.49	109	35	09.83				
$\frac{35}{1}$	2,479.143	47	44	24.37	109	33	02.51	200	14	30	994.6
$\frac{35}{2}$	2,471.530	47	44	33.29	109	32	57.48				
$\frac{36}{1}$	2,480.411	47	44	32.31	109	30	50.45	202	11	00	1,368.4
$\frac{36}{2}$	2,463.721	47	44	44.79	109	30	43.30				
$\frac{37}{1}$	2,480.507	47	43	44.60	109	28	27.95	168	01	00	891.3
$\frac{37}{2}$	2,472.851	47	43	53.20	109	28	30.65				
$\frac{38}{1}$	2,467.725	47	43	13.34	109	24	43.30	148	27	30	1,306.5
$\frac{38}{2}$	2,465.305	47	43	24.33	109	24	53.30				
$\frac{39}{1}$	2,486.245	47	44	27.95	109	22	09.16	162	24	10	906.6
$\frac{39}{2}$	2,444.738	47	44	36.49	109	22	13.17				
$\frac{40}{1}$	2,445.146	47	46	04.06	109	17	54.43	127	35	10	984.49
$\frac{40}{2}$	2,445.360	47	46	09.99	109	18	05.85				
$\frac{41}{1}$	2,420.556	47	47	28.19	109	14	40.69	180	20	10	1,049.69
$\frac{41}{2}$	2,429.424	47	47	38.55	109	14	40.60				
$\frac{42}{1}$	2,428.705	47	47	17.56	109	11	12.73	200	04	15	1,019.81
$\frac{42}{2}$	2,420.339	47	47	27.01	109	11	07.60				
$\frac{43}{1}$	2,405.939	47	47	05.78	109	06	37.21	144	00	25	1,528.34
$\frac{43}{2}$	2,418.427	47	47	17.98	109	06	50.37				
$\frac{44}{1}$	2,415.313	47	47	47.42	109	03	40.09	191	09	19	1,323.2
$\frac{44}{2}$	2,397.566	47	48	00.36	109	03	36.33				
$\frac{45}{1}$	2,398.415	47	47	52.78	109	00	50.32	137	45	25	1,136.14
$\frac{45}{2}$	2,394.520	47	48	01.09	109	01	01.50				
$\frac{46}{1}$	2,407.905	47	47	24.68	108	56	45.72	183	09	25	1,274.6
$\frac{46}{2}$	2,379.845	47	47	37.25	108	56	44.69				
$\frac{47}{1}$	2,383.408	47	45	32.67	108	55	27.62	237	07	40	1,385.32
$\frac{47}{2}$	2,386.033	47	45	40.09	108	55	10.59				
$\frac{48}{1}$	2,365.804	47	44	00.95	108	54	27.29	184	52	40	1,749.60
$\frac{48}{2}$	2,391.438	47	44	18.16	108	54	25.11				
$\frac{49}{1}$	2,369.839	47	43	04.52	108	50	40.13	200	31	30	1,884.21
$\frac{49}{2}$	2,382.479	47	43	21.94	108	50	30.47				
$\frac{50}{1}$	2,380.464	47	41	56.44	108	48	50.99	231	50	22	1,983.17
$\frac{50}{2}$	2,369.792	47	42	08.53	108	48	28.19				
$\frac{51}{1}$	2,403.087	47	40	15.70	108	47	21.00	262	29	55	3,112.36
$\frac{51}{2}$	2,367.020	47	40	19.71	108	46	35.90				
$\frac{52}{1}$	2,358.504	47	38	31.50	108	45	26.68				
$\frac{52}{2}$	2,346.894										
$\frac{53}{1}$	2,397.132	47	38	04.99	108	42	58.02	190	19	15	3,657.97
$\frac{53}{2}$	2,348.817	47	38	40.52	108	42	48.45				
$\frac{54}{1}$	2,346.327	47	37	07.12	108	40	39.45	185	26	05	3,273.26
$\frac{54}{2}$	2,355.039	47	37	39.28	108	40	34.93				
$\frac{55}{1}$	2,369.439	47	37	18.91	108	36	34.40	196	50	05	2,135.11
$\frac{55}{2}$	2,350.881	47	37	39.07	108	36	25.38				
$\frac{56}{1}$	2,328.814	47	36	41.51	108	32	02.19	179	56	25	3,179.07
$\frac{56}{2}$	2,341.203	47	37	12.90	108	32	02.24				
$\frac{57}{1}$	2,346.926	47	35	52.45	108	28	10.57	16	01	00	6,274.5
$\frac{57}{2}$	2,327.694	47	36	51.98	108	27	45.32				
$\frac{58}{1}$	2,351.943	47	34	50.74	108	24	38.94	189	09	17	5,873.27
$\frac{58}{2}$	2,348.606	47	35	47.98	108	24	25.33				
$\frac{59}{1}$	2,350.873	47	34	24.25	108	22	31.31	206	03	40	5,588.2

Elevations and geographical positions of bench marks, primary leveling, 1885–1892, Fort Benton, Montana, to Cannon Ball, North Dakota—Continued.

[The datum plane is approximately 77.4 feet below mean tide near New York. Azimuths and distances are from bench 1 to bench 2 of same line.]

Bench mark.	Elevation.	Latitude.			Longitude.			Azimuth.			Distance.
	Feet.	°	′	″	°	′	″	°	′	″	*Feet.*
59/2	2,322.967	47	35	13.80	108	21	55.44				
60/1	2,306.177	47	34	54.52	108	19	31.21	215	27	20	1,987.6
60/2	2,330.799	47	35	10.51	108	19	14.91				
61/1	2,315.649	47	34	39.27	108	15	51.96	170	40	16	3,440.49
61/2	2,331.280	47	35	12.78	108	16	00.10				
62/1	2,299.724	47	35	12.24	108	11	45.88	198	53	00	1,301.1
62/2	2,322.657	47	35	24.39	108	11	39.73				
63/1	2,310.799										
63/2	2,306.379	47	35	27.97	108	08	33.54				
64/1	2,314.847	47	35	22.31	108	05	40.40	202	46	55	4,195.85
64/2	2,327.977	47	36	00.49	108	05	16.70				
65/1	2,316.081	47	34	48.34	108	01	31.16	189	36	58	3,027.68
65/2	2,289.644	47	35	17.81	108	01	23.78				
66/1	2,354.610	47	34	12.56	107	58	04.33	221	03	20	4,310.7
66/2	2,290.947	47	34	44.65	107	57	23.05				
67/1	2,292.071	47	32	11.27	107	55	44.92	256	52	25	3,796.64
67/2	2,286.712	47	32	19.77	107	54	51.02				
68/1	2,301.657	47	29	32.57	107	54	26.34	249	06	49	3,359.31
68/2	2,286.269	47	29	44.39	107	53	40.62				
69/1	2,283.981	47	27	14.60	107	54	46.06	244	58	10	2,460.2
69/2	2,276.381	47	27	25.17	107	54	13.66				
70/1	2,271.050	47	28	11.84	107	51	18.76	82	18	00	3,428.5
70/2	2,293.004	47	28	07.33	107	52	08.38				
71/1	2,261.241	47	30	22.67	107	51	33.89	78	27	20	2,797.0
71/2	2,273.351	47	30	17.14	107	52	13.79				
72/1	2,272.761	47	31	33.35	107	49	55.67	138	02	11	3,732.76
72/2	2,287.460	47	32	00.74	107	50	32.01				
73/1	2,202.831	47	32	27.85	107	47	33.67	175	19	50	5,284.8
73/2	2,273.607	47	33	19.85	107	47	39.95				
74/1											
74/2	2,260.637	47	34	19.71	107	44	56.09				
75/1	2,277.103										
75/2	2,246.112										
76/1	2,256.549	47	37	02.80	107	39	47.17	175	30	26	6,708.7
76/2	2,246.189	47	38	08.71	107	39	54.73				
77/1	2,260.849	47	38	19.70	107	31	47.66	210	52	30	2,263.8
77/2	2,238.676	47	38	38.88	107	31	30.65				
78/1	2,235.859	47	38	52.40	107	25	48.43	134	05	35	1,808.0
78/2	2,254.273	47	39	04.82	107	26	07.39				
79/1	2,226.431	47	40	31.58	107	16	41.07	212	09	20	1,797.8
79/2	2,240.961	47	40	46.61	107	16	27.09				
80/1	2,237.360	47	39	27.53	107	02	18.50	140	29	45	3,369.8
80/2	2,219.563	47	39	53.20	107	02	49.88				
81/1	2,221.977	47	42	13.31	106	52	00.00	110	34	30	3,477.7
81/2	2,191.187	47	42	25.32	106	52	47.56				
82/1	2,216.711	47	43	34.19	106	45	18.13	201	51	25	2,665.0
82/2	2,177.316	47	43	58.61	106	45	03.66				
83/1	2,185.086	47	45	52.36	106	40	34.52	160	24	50	7,056.4
83/2	2,185.551	47	46	57.98	106	41	09.13				
84/1	2,207.512	47	46	44.26	106	36	09.42	169	19	10	11,316.0
84/2	2,196.295	47	48	34.01	106	36	40.11				
85/1	2,163.995	47	51	14.78	106	31	26.13	136	19	10	8,360.6
85/2	2,171.295	47	52	14.29	106	32	51.13				
86/1	2,171.661	47	54	41.51	106	29	38.40	90	08	00	7,932.0
86/2	2,144.634	47	54	41.59	106	31	34.51				
87/1	2,135.542	47	57	42.36	106	27	38.67	13	11	20	7,616.2
87/2	2,184.544	47	58	55.56	106	27	13.14				
88/1	2,192.834	47	58	14.32	106	24	24.24				
89/1	2,188.660	48	01	52.50	106	25	01.74	100	07	03	4,521.2
89/2	2,127.229	48	02	00.33	106	26	07.20				
90/1	2,163.642	48	02	30.60	106	21	14.52				
91/1	2,187.728	48	01	57.91	106	15	42.51	201	26	42	4,637.2
91/2	2,109.597	48	02	37.75	106	15	19.25				
92/1	2,155.597	48	00	35.66	106	09	23.06	219	59	20	11,602.3
92/2	2,138.918	48	02	03.41	106	07	33.38				
93/1	2,092.801	48	00	06.48	106	02	10.97	203	14	50	12,914.6
93/2	2,138.058	48	02	04.41	106	00	56.65				
94/1	2,127.322	48	00	03.39	105	55	15.05	217	06	55	10,746.1
94/2	2,080.092	48	01	27.98	105	53	39.66				
95/1	2,075.017	48	01	12.9[illegible]	105	47	14.33	186	15	10	11,842.7
95/2	2,070.893	48	03	09.19	105	46	55.37				
96/1	2,076.456	48	01	43.52	105	42	58.02	204	18	00	12,760.0
96/2	2,067.396	48	03	38.17	105	41	40.64				
97/1	2,116.326	48	02	34.66	105	39	33.21	197	11	26	12,992.4
97/2	2,071.514	48	04	37.18	105	38	36.72				
98/2	2,057.514	48	05	55.17	105	35	05.33				
99/2	2,053.196	48	06	30.68	105	30	43.14				
100/2	2,048.230	48	07	00.97	105	26	45.30				
101/2	2,050.226	48	07	12.96	105	22	45.05				

Elevations and geographical positions of bench marks, primary leveling, 1885–1892, Fort Benton, Montana, to Cannon Ball, North Dakota—Continued.

[The datum plane is approximately 77.4 feet below mean tide near New York. Azimuths and distances are from bench 1 to bench 2 of same line.]

Bench mark.	Elevation.	Latitude.			Longitude.			Azimuth.	Distance.
	Feet.	°	′	″	°	′	″	° ′ ″	*Feet.*
$\frac{102}{2}$	2,041.601	48	07	46.55	105	19	06.75		
$\frac{103}{2}$	2,036.010	48	07	06.19	105	15	35.95		
$\frac{104}{2}$	2,065.015	48	06	30.88	105	11	42.50		
$\frac{105}{2}$	2,032.277	48	06	20.23	105	08	33.66		
$\frac{106}{2}$	2,079.760	48	05	32.02	105	04	20.45		
$\frac{107}{2}$	2,061.240	48	05	50.26	104	59	59.89		
$\frac{108}{2}$	2,055.916	48	07	39.62	104	56	49.40		
$\frac{109}{2}$	2,031.845	48	09	09.67	104	53	49.50		
$\frac{110}{2}$	2,004.356	48	08	58.07	104	50	03.87		
$\frac{111}{2}$	2,018.503	48	08	29.30	104	45	33.55		
$\frac{112}{2}$	2,018.254	48	08	50.40	104	41	25.35		
$\frac{113}{2}$	1,995.337	48	08	43.81	104	37	07.90		
$\frac{114}{2}$	1,990.750	48	08	07.45	104	33	15.33		
$\frac{115}{2}$	1,997.118	48	07	38.98	104	29	37.96		
$\frac{116}{2}$	2,001.675	48	06	36.33	104	26	14.94		
$\frac{117}{2}$	1,994.968	48	04	21.10	104	21	43.53		
$\frac{118}{2}$	1,995.747	48	03	13.88	104	17	31.98		
$\frac{119}{2}$	1,997.142	48	02	38.95	104	14	01.13		
$\frac{120}{2}$	1,977.466	48	04	38.83	104	11	04.67		
$\frac{121}{2}$	1,978.568	48	03	35.93	104	07	51.35		
$\frac{122}{2}$	1,969.542	48	01	45.81	104	05	16.10		
$\frac{123}{2}$	1,979.176	48	00	07.92	104	02	42.07		
$\frac{124}{2}$	1,971.399	47	59	02.48	104	00	02.24		
Buford gauge	1,953.383								
$\frac{125}{2}$	1,980.432	48	00	05.18	103	55	56.88		
$\frac{126}{2}$	1,971.194	48	01	53.78	103	52	28.91		
$\frac{127}{2}$	1,982.204	48	04	05.32	103	50	20.09		
$\frac{128}{2}$	1,960.328	48	05	01.48	103	46	50.11		
$\frac{129}{2}$	1,937.476	48	06	29.31	103	43	11.26		
$\frac{130}{2}$	1,967.849	48	08	08.01	103	40	54.17		
$\frac{131}{2}$	1,943.135	48	08	34.88	103	37	06.27		
$\frac{132}{2}$	1,948.474	48	07	29.34	103	33	30.47		
$\frac{133}{2}$	1,937.249	48	05	03.95	103	32	42.17		
$\frac{134}{2}$	1,932.304	48	03	03.36	103	32	16.60		
$\frac{135}{2}$	1,964.466	48	01	35.11	103	28	55.49		
$\frac{136}{2}$	1,917.546	48	02	49.70	103	24	36.23		
$\frac{137}{2}$	1,926.630	48	03	33.80	103	20	46.17		
$\frac{138}{2}$	1,920.518	48	03	30.08	103	17	06.07		
$\frac{139}{2}$	1,930.645	48	06	02.36	103	14	48.50		
$\frac{140}{2}$	1,901.181	48	08	27.20	103	11	47.98		
$\frac{141}{2}$	1,904.049	48	09	29.45	103	07	51.49		
$\frac{142}{2}$	1,887.177	48	08	56.42	103	03	43.17		
$\frac{143}{2}$	1,903.226	48	08	42.30	102	59	03.99		
$\frac{144}{1}$	2,061.831	48	06	40.94	102	56	39.06		
$\frac{145}{1}$	1,947.721	48	07	07.23	102	49	47.75		
$\frac{145}{2}$	1,892.268								
$\frac{146}{2}$	1,968.073	48	06	01.89	102	40	52.56		
$\frac{147}{2}$	1,939.751	48	02	55.07	102	36	37.53		
$\frac{148}{2}$	1,953.108	47	59	29.19	102	32	44.63		
$\frac{149}{2}$	1,893.195	47	54	39.11	102	37	48.30		
$\frac{150}{2}$	1,892.452	47	50	18.85	102	38	23.17		
$\frac{151}{2}$	1,885.343	47	47	14.37	102	31	57.52		
$\frac{152}{2}$	1,840.808	47	46	04.05	102	23	19.41		
$\frac{153}{2}$	1,870.738	47	46	58.49	102	15	23.01		
$\frac{154}{2}$	1,874.328	47	43	49.97	102	15	30.31		
$\frac{155}{2}$	1,849.454	47	40	56.18	102	13	31.46		
$\frac{156}{2}$	1,919.291	47	37	25.00	102	14	24.82		
$\frac{157}{2}$	1,846.116	47	36	06.21	102	09	35.89		
$\frac{158}{2}$	1,868.693	47	35	23.56	102	05	20.08		
$\frac{159}{2}$	1,834.594	47	33	20.84	101	59	34.40		
$\frac{160}{2}$	1,889.727	47	32	13.85	101	56	37.48		
$\frac{161}{2}$	1,797.927	47	30	21.55	101	54	32.17		
$\frac{162}{2}$	1,824.490	47	30	45.89	101	48	43.53		
$\frac{163}{2}$	1,833.374	47	32	09.76	101	44	11.05		
$\frac{164}{2}$	1,836.684	47	32	24.63	101	40	06.65		
$\frac{165}{2}$	1,833.999	47	32	58.14	101	33	07.36		
$\frac{166}{2}$	1,806.223	47	34	14.62	101	27	34.43		
$\frac{167}{2}$	1,817.777	47	33	31.46	101	23	43.01		
$\frac{168}{2}$ = △ Robinson	2,003.040	47	32	12.06	101	21	53.01		
$\frac{169}{2}$	1,802.620	47	29	11.17	101	23	51.27		
$\frac{170}{2}$	1,776.261	47	26	13.57	101	24	36.84		
$\frac{171}{2}$	1,821.830	47	22	57.66	101	21	39.57		
$\frac{172}{2}$	1,820.329	47	19	21.32	101	20	29.53		
$\frac{173}{2}$	1,822.812	47	17	35.37	101	16	56.74		
$\frac{174}{2}$	1,807.793	47	16	08.38	101	13	57.57		
$\frac{175}{2}$	1,815.180	47	17	13.81	101	10	08.94		
$\frac{176}{2}$	1,776.847	47	17	57.52	101	04	08.41		
$\frac{177}{2}$	1,817.907	47	16	09.25	100	59	30.79		
$\frac{178}{2}$	1,793.982	47	12	22.71	100	56	39.16		

Elevations and geographical positions of bench marks, primary leveling, 1885–1892, Fort Benton, Mont., to Cannon Ball, North Dakota—Continued.

[The datum plane is approximately 77.4 feet below mean tide near New York. Azimuths and distances are from bench 1 to bench 2 of same line.]

Bench mark.	Elevation.	Latitude.	Longitude.	Azimuth.	Distance.
	Feet.	° ′ ″	° ′ ″	° ′ ″	*Feet.*
179	1,771.339	47 09 35.41	100 56 51.03		
180	1,755.303	47 06 54.01	100 55 59.49		
181	1,788.118	47 03 04.51	100 52 41.54		
182	1,874.570	46 59 23.27	100 53 04.94		
183	1,874.668	46 56 59.57	100 53 53.02		
184	1,786.334	46 53 32.82	100 51 28.07		
184	1,730.172	46 52 19.31	100 53 14.68		
Mandan	1,721.857				
185	1,758.288	46 50 00.77	100 49 57.44		
Bismarck Bridge, Pier No. 1	1,761.902				
Bismarck Brewery	1,746.232				
186	1,739.397	46 48 19.37	100 48 31.02		
187	1,760.379	46 45 55.63	100 50 43.82		
188	1,799.961	46 42 15.82	100 49 01.82		
189	1,767.124	46 42 12.15	100 45 01.00		
190	1,703.176	46 40 42.00	100 41 57.40		
191	1,733.504	46 40 49.96	100 37 39.40		
192	1,790.654	46 37 25.15	100 39 24.45		
193	1,730.170	46 37 49.31	100 33 13.05		
194	1,710.686	46 34 41.30	100 35 34.92		
195	1,731.337	46 31 52.32	100 32 20.90		
196	1,718.686	46 30 06.98	100 35 00.52		
197	1,707.210	46 27 21.55	100 34 54.04		

A A 2.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

The project of improvement was suspended in 1887 in order that the whole matter might be reported to Congress, and for reasons given in Appendix X 2 to the Annual Report of the Chief of Engineers, 1887.

No appropriation for work has been made since 1886.

A report of preliminary examination, 1891, naming a plan of improvement of the river from Glendive to its mouth and an estimate of its cost, is given on pages 2239–2242, Annual Report Chief of Engineers, 1891.

No operations were conducted during the year.

The appropriation asked for 1894 is for procuring a plant for dredging and sluicing at the bars on the river below Glendive, Mont., and one year's operation thereof, the funds to be used whenever boating on the river may be resumed. It is likely to be resumed within a year or two years.

Money statement.

July 1, 1891, balance unexpended	$11,766.20
June 30, 1892, amount expended during fiscal year	45.33
July 1, 1892, balance unexpended	11,720.87
July 1, 1892, outstanding liabilities	.71
July 1, 1892, balance available	11,720.16
Amount (estimated) required for completion of existing project	106,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

There is no steamboating on the river. A brisk traffic formerly existed, which ceased in 1885, after the Northern Pacific Railroad penetrated Montana. Below Glen-

dive there is no railroad in the Yellowstone Valley, and no prospect of there being any. Prospects exist for competing rail lines to reach Bismarck or Berthold from the east, and which would probably use the rivers above for feeders. The Soo railroad has a bed graded, about 125 miles, to Bismarck from Boynton, N. Dak., the western point in that State of its present operated lines. Without boating on the Yellowstone below Glendive transportation here means a wagon haul to and from Glendive or to and from a point on the Great Northern road and ferriage across the Missouri River. This railroad, coming from the east, strikes the Missouri on its north side at Williston, N. Dak., about 40 miles below the mouth of the Yellowstone, and again at Fort Buford, about opposite the mouth. It appears that there should, naturally, be local boating between Glendive and a Missouri River point on the Great Northern road, and, perhaps, also to some river point further downstream, as Berthold or Bismarck, where a rail line from the east may terminate.

There is a line of settlements along the river from its mouth up, and a stage and mail road from Buford to Glendive.

The area of land below Glendive and between bluffs is about 200 square miles, of which some two-thirds is bottom and the remainder first-bench land. The June river rise rarely covers the bottom, but at places they are frequently submerged during spring breakups by backwaters from ice gorges.

Vegetation on bottom and bench lands is prolific until about the end of June, when the dry months commence. Without rain or irrigation farming is out of the question. The hot sun of July and August, while damaging vegetation, cures the luxuriant grass, making nutritious food for stock. Grazing is, therefore, the present principal industry, one product of which, wool, can advantageously be carried by boat. Lignite coal crops out in about 4 and 5 foot veins in the river banks, and pieces of coal as large as barrels and hogsheads have been seen on the bars or along the shores. The coal is apparently as good as that mined in eastern Montana or Dakota.

A A 3.

[Printed in House Ex. Doc. No. 114, Fifty-second Congress, first session.]

PRELIMINARY EXAMINATION OF MISSOURI RIVER, MONTANA, BETWEEN GREAT FALLS AND CAÑON NEXT BELOW STUBBS FERRY.

ENGINEER OFFICE, UNITED STATES ARMY,
St. Louis, Mo., March 19, 1891.

GENERAL: I have the honor to report from an examination made by me that the Missouri River between Great Falls and cañon next below Stubbs Ferry is worthy of improvement.

The water named is readily susceptible of improvement for a profitable light-draft navigation. The country tributary to it is now productive in a small measure (and will be, it is judged, extensively productive) of articles of a heavy traffic, which generally seek water transportation. It is timbered and mineral, or in part grazing and agricultural. Useful stone and coal are also reported. A market for the products indicated exists at Great Falls, a place whose shipping and manufacturing interests, especially ore smelting and lumber ones, are rapidly growing. This city, barely 7 years old, already ranks in population as the third one in Montana. It has an excellent site for a large town, is the natural center of an extensive country, has good railroad facilities, and a water power, furnished by the adjacent falls of the Missouri River, not excelled in the United States.

Detailed commercial statistics and a history of navigation on the Missouri River above Great Falls are given in an extract of a report herewith of Lieut. J. C. Sanford, Corps of Engineers, concerning the obstruction of navigation by the building of a proposed dam and bridge across the Missouri at the cañon next below Stubbs Ferry. Attention is also invited to the appended statement of a committee of the Great Falls Board of Trade.

Stubbs Ferry is about 12 miles northeast of Helena; the cañon is 3 or 4 miles downstream. The new settlements of Cascade and St. Clair are about 76 miles further, and Great Falls is 50 miles below them.

Gallatin, near the junction of the three forks which form the Missouri, is 78½ miles above Stubbs Ferry and 40 miles above Townsend, a point mentioned in Lieut. Sanford's report. Sun River empties into the Missouri just above Great Falls.

In 1880, under orders of the Engineer Department, Capt. Edward Maguire, Corps of Engineers, made a survey of the Missouri River from Stubbs Ferry to Sun River. Following the survey some work of improvement, consisting of stone dams and rock removal, was executed in that year. In 1890 the Missouri River Commission made a detailed survey of the river from Gallatin to Fort Benton, below Great Falls, and at a very low stage of river and one considerably lower than obtained during the first survey.

There is no need, therefore, of a new survey. A plan of improvement can be prepared from the maps and other data of the two surveys. The maps of the Commission survey are, I am lately informed, unavoidably delayed, and for assistance in the mapping of the part from the cañon to Great Falls, in order to secure prompt use of the maps useful in preparing the plan, I estimate that $750 are needed.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., March 27, 1891.

Respectfully forwarded to the office of the Chief of Engineers.

It is with great reluctance that I concur in the opinion of the local engineer that the Missouri River between Great Falls and cañon next below Stubbs Ferry is worthy of improvement by the General Government; but the commercial developments of the locality have been so rapid as to seem to justify the prompt mapping of the surveys already made.

I therefore recommend that the proposition of Capt. Powell be approved; if not for the full amount named by him, at least for a portion of it.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

REPORT OF LIEUTENANT J. C. SANFORD, CORPS OF ENGINEERS.

ST. LOUIS, MO., *September 16, 1890.*

SIR: * * * The first effort toward navigating the upper river by steamboats was made in 1879 by the Montana Navigation Company, composed of five of the leading business men and shippers of Helena. At that time Helena was the principal and only important distributing point in Montana. Nearly all the Montana supplies came up by steamboat to Benton, and thence were hauled by wagon to Helena, 140 miles. The object of the company was to reduce this wagon haul, substituting water transportation for about three-fourths of the distance. The company expended (so one of its members informed me) about $10,000 on the improvement of the river; but before a steamboat was procured, the idea was abandoned.

In 1883 a small stern wheel pleasure boat, 33 feet long, was placed in the river by Governor Crosby and others for hunting purposes. She was unable to stem the current, and was never used after her trial trip. Since then she has completely broken up. In 1887 two steamboats were put in the river. One was a stern-wheel, steel hull pleasure boat, the *Rose*, owned by Judge Hilger, of Helena, and intended to carry parties through the magnificent cañon known as White Rock Cañon or Gate of the Mountains, just below his ranch. She was built at Dubuque, Iowa, and is about 50 feet long by 10 feet beam, and draws 15 inches light. She has considerable power (her guaranteed speed is 12 miles an hour in still water), and has passed up through all the rapids between Stubbs Ferry and the Long Pool without cordelling, and with comparative ease. Since she was put on she has been running every season on short trips, and has, I understand, proved quite profitable. The other boat is the *Fern* of Great Falls. Her hull was built on the Jefferson River, and floated down to Townsend, on the Missouri, where her machinery was put in; thence she proceeded to Great Falls. She is 88 feet long by 20 feet beam, draft 2.5 feet light, 3.5 feet loaded, and her engine is of 26 horse power. She is intended for freight and passenger service, usually towing her freight on a barge 80 by 40 feet. On account of insufficient funds, she was not properly built and her power is too small, preventing her from going above the Long Pool. No steamboats have been placed in the upper river since 1887, though Capt. Taylor of Great Falls expects to have next summer a 53-foot naphtha launch with an engine of 125 horse power and a speed of 15 miles per hour, to ply on the Long Pool and perhaps above; and two other naphtha launches will, it is said, be put in the river next summer by Great Falls parties.

For the past three years the *Fern* has been running, somewhat irregularly, on the Long Pool. Last year she carried 4,500 cords of wood, 158,000 pounds of wool, 250 tons baled hay, and 5 tons vegetables; as well as about 500 passengers.

During last season 2,000,000 feet of sawed lumber was floated to Great Falls, in small rafts, from sawmills on the cañon section of the river. This season, up to August 13, 3,500,000 feet sawed lumber and logs have been floated down to Great Falls; also 70,000 linear feet piling, 12,000 railroad ties, and 4,500 telegraph poles.

From a personal inspection of about one-half of the cañon section, and from Judge Hilger's experience with his yacht, I believe that small freight steamers could be built capable of navigating the rapids. They must combine light draft with great power, and must admit of being easily handled.

* * * * * * *

DEMANDS OF COMMERCE.

Within the last three years the thriving city of Great Falls has sprung up at the foot of the Long Pool. It contains with suburbs, between 5,000 and 5,500 inhabitants, the population having doubled in the last year; and it bids fair to continue increasing at about the same rate for some time to come. The tremendous water power afforded by the series of Missouri River Falls (total fall, 547 feet), at the head of which it is situated, is the chief cause of its past and expected growth. It is the center of a large ranching and wool-growing district (2,500,000 pounds of wool were shipped from there last year), and is only 15 miles distant from the Sandcoulee coal mines, which supply a large part of Montana and North Dakota. A railroad connects Great Falls with these mines and continues to Monarch, 53 miles, whence it will be carried shortly to the silver, gold, and lead mines of the Neihart and Barker districts, 12 and 20 miles farther, respectively.

The town is now the terminus of four railroads. A flouring mill and a large silver smelter, which cost $2,000,000, are now in operation. An immense copper smelter, to cost $6,000,000, is being built at Black Eagle Falls, and a dam, to cost $500,000, is nearly completed just above these falls. A large lumber company expects to put up a plant costing $250,000 at Great Falls, for sawing and finishing lumber, bringing its logs down the Missouri and its tributaries. At present three-fourths of the lumber used in Montana on the east side of the main Rockies is brought from Missoula and other points on the west side at great expense. A careful examination made this year, of most of the tributaries of the Missouri, has proved both the existence of considerable supplies of lumber along these tributaries and the practicability of using the streams for driving logs to Great Falls. During my visit the announcement was made that the Anaconda Copper Mining Company, of Butte, had decided to locate their smelter at Great Falls; but I can not vouch for the truth of this. Such a smelter would give employment to 2,000 hands.

From what I saw of Montana it appears to me probable that nearly all the mines of the State that lie on the east side of Rockies, and many of those on the west side, will eventually send their ores to be smelted at Great Falls. Of the five silver smelters that I saw on the east slope, only the one at Great Falls was in operation. The $6,000,000 copper smelter above mentioned is being built by the Boston and Montana Copper Mining Company, of Butte (on the west side of the main divide), and a con-

tract has been made with the Montana Central Railroad for hauling 1,000 tons of ore daily after April 1, 1891, from Butte to Great Falls.

Were the Missouri regularly navigated, some ore would probably be shipped to Great Falls by water. The silver smelter at Great Falls receives, on an average, 20 tons of ore per day from Toston, Townsend, and Bedford, stations on the Northern Pacific Railroad, and situated on the river. For this transportation the miners pay local rates on two railroads, as the Northern Pacific does not reach Great Falls, making the cost several dollars per ton. I am told that some of these miners have threatened, this summer, to send their ore to Great Falls on barges, if the rates were not reduced. As an example of freight rates in Montana, it is said that the Great Northern Railway charges $3.20 per cord for hauling wood from Monarch to Great Falls, 53 miles; and that the Montana Central charges 60 cents per 100 pounds for hauling farm produce from Cascade to Great Falls, 29 miles.

Most of the cultivated land along the Missouri above Great Falls is contained in two large valleys—that in which the Long Pool is situated, and the Townsend or Missouri Valley above Stubbs Ferry. The first has Cascade (population 500) for its principal town, and contains a population estimated at between 2,000 and 3,000. Much wool is grown in this valley. The population of the second valley is estimated at between 3,000 and 4,000. Townsend (population 500) is its principal town.

In ordinary seasons agriculture, everywhere in Montana, requires irrigation, and, on account of the impracticability of irrigating the high levels, is confined to the river valleys. The comparative small area of these, and the exorbitant rates of transportation from the East, keep the prices of farm produce in Montana very high, and justify expensive systems of irrigation. In both of the valleys mentioned, considerable irrigation has been done, and much more extensive systems are in progress. I am informed that 2,000,000 bushels of grain were raised last year in the Townsend Valley, and 60,000 in Crow Creek Valley (a tributary valley). The soil is very fertile. and with increased irrigation, largely increased production may be looked for.

The portion of the upper river not contained in these two valleys passes either through small valleys or cañons. A population of perhaps 500 is found in these valleys, principally occupied in lumbering or stock raising. There are large charcoal furnaces in the Prickly Pear Cañon (a side cañon), about 4 miles from the Missouri. These ship 2,000 bushels per day to the silver smelter at Great Falls.

Judge Hilger informed me that there was a copper mine 2 miles from his place, and numerous veins of gold-bearing quartz of rather low grade; that there were immense quantities of iron ore at Bear Teeth Mountain near the river, and a bed of slate of excellent quality, all these awaiting cheaper transportation and labor before being developed. * * * If the whole river were ever so improved, with proper arrangements for the transfer of cargoes around the Falls, as to render a reliable and economical transportation route to the Mississippi, not only Helena but the whole of Montana would receive immense benefit. From merely local navigation, however, the benefits would be derived mainly by Great Falls, to which the whole upper river would become a feeder, and by the smaller towns along the river; while the trade of Helena might even be injured thereby.

* * * * * * *

Very respectfully, your obedient servant,

J. C. SANFORD,
First Lieutenant of Engineers,
Secretary Missouri River Commission.

Lieut. Col. CHAS. R. SUTER,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

STATEMENT OF COMMITTEE OF BOARD OF TRADE OF GREAT FALLS, MONTANA.

GREAT FALLS, MONT., *November 28, 1890.*

DEAR SIR: We, the undersigned, members of a committee appointed by the Board of Trade of Great Falls, Mont., beg leave to call the attention of your Department to the fact that it is the opinion of the board that the Missouri River, with the exception of slight obstacles at two different points, is navigable from Great Falls to the mouth of the Gallatin River. The country through which it flows between these points is an important agricultural and mineral district, with a large amount of timber tributary to it. The most expedient and economical way to handle the products of this region for a distance of about 300 miles is by water transportation. Great Falls and intermediate points afford a natural and sufficient market for these products of this thickly settled country along the Upper Missouri River Valley, and in many places they have no other convenient outlet. For the past three seasons

two small steamers have successfully plied these waters and have demonstrated that continuous navigation of the Upper Missouri is practicable, provided the removal of obstructions at Bear Tooth Ford and Half Breed Rapids is effected. Aside from this and the confining of the waters into one channel at numerous places there is very little to be done in the way of improvement.

Material for the work is convenient along this entire distance. The formation of the river bed is of rock and gravel. Improvements once made in this channel would be of a permanent nature, and, unlike those of the Lower Missouri, would not demand annual repairs. The river between Great Falls and the Gallatin is open about nine months of the year, and during this period has an ample stage of water. We believe the removal of the obstacles referred to, thereby making this part of the river navigable, and which can be done at a small expenditure of money, is as important as the construction of a railroad in any part of the United States. The railroad at Great Falls provides a portage around the series of falls below Great Falls, so that the Missouri can be made a practical element in transportation from its sources to the Gulf of Mexico. Great Falls is an important manufacturing point, and its mills and smelters will depend largely upon this water transportation for ores, grain, wood, and lumber. From official reports on file in your Department the statements above can be verified. This communication will be supplemented with others placing the matter before you in detail.

Respectfully submitted.

J. STEWART TOD, *Chairman.*
TIMOTHY E. COLLINS.
ERNEST CRUTCHER.
CHAS. M. WEBSTER.
CHAS. WEGNER.

The SECRETARY OF WAR.

PROJECT FOR IMPROVEMENT OF MISSOURI RIVER, MONTANA, BETWEEN GREAT FALLS AND CAÑON NEXT BELOW STUBBS FERRY.

ENGINEER OFFICE, UNITED STATES ARMY,
Sioux City, Iowa, January 23, 1892.

GENERAL: Having reported that the Missouri River between Great Falls and cañon next below Stubbs Ferry, Montana, was worthy of improvement for light-draft navigation, I have now the honor to submit a plan for improvement of the water named and an estimate of its cost.

The information on which the plan is based is derived principally from the maps of the engineer survey of the river in 1880; Capt. Maguire's report in connection therewith, published on page 1339 of the Chief of Engineers' Report, 1883, to which reference is invited; the survey made in 1890 under the Missouri River Commission, and subsequent inspections of the river.

On part of the river, known as the Long Pool, whose character is indicated by that name and which extends for 51 miles upstream from Great Falls, the channel naturally is fairly good and of depths sufficient at low stages for boats drawing 3 feet.

It is desirable to extend this 3-foot channel 4 miles farther, or to the small towns on opposite sides of the river called, one, Cascade, and the other, St. Clair. These towns are about at the foot of the cañon part of the river; wagon roads from the back country intersect the river here; Cascade has stage connections with a number of points, and St. Clair is the outlet for the Chestnut Valley, the largest agricultural district between Stubbs Ferry and Great Falls. On the 4 miles of river named the slopes are sharper and the depths some less than below; there are 13 islands on this small part, while on the much longer distance to Great Falls there are only 32. Two thousand feet of dams are projected here for concentrating the flow or lengthening the slope, at $7.50 per foot, and 3,500 feet of bank protection at $5 per foot.

Above Cascade and St. Clair to the cañon next below Stubbs Ferry, a length of 60 miles, the river is characterized by cañons, where the channel is generally good, although the water is strong; by frequent rapids where the slopes are steep and obstructive rocks exist; and by gravel shoals where the mountains are retired, the river widens out, and its water is dispersed through two or more chutes. To provide a channel on this reach of 2.5 feet deep at low water, which appears to be the practicable limit, especially toward the upper part, where ledge rock at places extends across the river, would require, it is estimated, 10,000 feet of dams and the removal of 670 yards of bowlders or projecting rock at $12 per yard. Other bowlders and rock can advantageously be marked by buoys; ten 8-foot spar buoys with iron fastenings are estimated therefor at $9.75 per buoy in place. On the Long Pool and for a few miles above there are about 20 snags in the way, whose removal will probably cost $10 each. The snagging, buoyage, and dams will require more or less maintenance after the first year.

SUMMARY OF ESTIMATE.

12,000 feet of dams, at $7.50	$90,000.00
3,500 feet of bank protection, at $5	17,500.00
670 yards of rock removal, at $12	8,040.00
10 buoys in place, at $9.75	97.50
20 snags removed, at $10	200.00
Total	115,837.50
Annual maintenance of dams, bank protection, buoys, and snag removal	4,500.00

Some conditions obtain at the Missouri River above Great Falls favorable for the improvement and its permanence. Stone and brush are abundant near by; the banks are generally stable; the water is clear; floods and ice-runs are not severe, and the period of closing of river by ice is shorter than on the Missouri in the Dakotas. The discharge of the upper river is quite equable. Even with the present dam at the extreme head of the falls the flood height there is about 12 feet, diminishing upstream until at Three Forks, or Gallatin, it is only 7 feet. The Long Pool is a noticeable stretch of good river, especially considering its proximity to the mountains.

The worst rapid all the way to Gallatin, 78 miles above Stubbs Ferry, appears to be Lone Pine, as named by Lewis and Clarke, or Half Breed, as now called. This rapid is 10 miles above Cascade and St. Clair. Fifty miles farther is Hilgers Landing, where an 18-mile wagon road from Helena comes in. This place is the headquarters of the small excursion steamer *Rose*, which during the summer and fall makes trips downstream through the Gate of the Mountains and White Rock Cañon, and occasionally upstream through the Helena Cañon, except at lowest stages, when the obstructions are too great for her navigation. Ten miles above Hilgers is the foot of the cañon next below Stubbs Ferry, making the part of the river under consideration for improvement 125 miles long. Stubbs Ferry is 6 miles farther. There is a good wagon road 12 miles long from here to Helena, which could readily be extended downstream a mile or two below a bad shoal near the Ferry, and from which point down the river is as good as from there to Hilgers. The scenery through the cañons and along the whole river is grand, and excelled only in river scenery of our whole country, it is believed, by that on the unnavigable part of the Colorado River. It would seem with little deeper water, the removal of the bad rocks, and amelioration at the worst rapids, that the river from near Helena to a station on the railroad between Helena and Great Falls would afford a grand and most

convenient tourist route. The rail line south from the falls crosses the Long Pool district and then follows the river from Cascade to Craig, 23 miles, near which it wholly leaves the river.

Commercial statistics are given with the report of the preliminary examination, March 19, 1891. Except in logging from near Stubbs Ferry to Great Falls, the present actual traffic on the river is small. The boating traffic of any extent is prospective; its considerable increase can not precede the navigation improvement. The river is there, in bad condition above the Long Pool; there is no probability of a railroad along the river above Craig for many years; productions of the country immediately tributary to the river appear promising, and a waiting market exists at the railroad and manufacturing point in Great Falls at the foot of the river reach.

Respectfully submitted.

CHAS. F. POWELL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., January 27, 1892.

Respectfully forwarded to the office of the Chief of Engineers, approved.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

APPENDIX B B.

IMPROVEMENT OF TENNESSEE RIVER ABOVE CHATTANOOGA, TENNESSEE, AND BELOW BEE TREE SHOALS, ALABAMA, OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF THEIR TRIBUTARIES IN EASTERN TENNESSEE AND KENTUCKY.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River above Chattanooga, Tennessee, and below Bee Tree Shoals, Alabama.
2. Hiawassee River, Tennessee.
3. French Broad River, Tennessee.
4. Clinch River, Tennessee.
5. Cumberland River, Tennessee and Kentucky.
6. Caney Fork River, Tennessee.
7. South Fork of Cumberland River, Kentucky.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., July 9, 1892.

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1892.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

B B 1.

IMPROVEMENT OF TENNESSEE RIVER.

(Length, 673 miles.)

The exact point at which the Tennessee River has its beginning is still a matter of some uncertainty. The Riviere des Cheraquis, or Cherake, of the early French explorers, and the Cherokee River as referred to in cessions to the English by the Indians in 1767, has been considered as being formed by the junction of what are now called the Little Tennessee and Holston rivers, near the town of Lenoirs, Tenn. Tannassee, the chief town of the Cherokee Indians, was situated near this point, and the fact that the river derives its present name from that town, seems to add additional weight to the arguments of the geographers who have placed the headwaters of the river at this junc-

tion. In some of the older geographies the head of this river has been placed at the mouth of the Clinch, and the Holston extended to that point.

The legislature of Tennessee in 1889, passed an act extending the name of the Tennessee River to the junction of the north and south forks of the Holston, at Kingsport, in Sullivan County, Tenn.

Congressional legislation, however, in several laws appropriating money for the improvement of the Upper Tennessee between Knoxville and Chattanooga, has given authority for extending the name at least to the former city, but as the junction of the Holston and French Broad rivers is but 4½ miles above Knoxville, this point is now generally taken as the origin of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the forty-three or more tributaries of the Mississippi River, the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigible from its source to its mouth, a distance of 673 miles, during several months of each year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river so as to make navigation continuous throughout its entire length for boats of moderate draft is by no meams an impossibility.

1. ABOVE CHATTANOOGA (188 miles).

This section of the river is navigable during medium and high stages, which usually prevail through the winter and spring months, and occasionally at other seasons during the occurrence of so-called rain tides.

The navigation consists of steamboats carrying freight and passengers, flatboats bringing products from the upper tributaries, and rafts of logs and lumber, also brought from the tributaries, the latter constituting the major part of the commerce of the Upper Tennessee River.

In 1830, Col. S. H. Long, United States Topographical Engineers, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as Executive Document No. 167, House of Representatives, Forty-third Congress, second session, gives a detailed description of every obstruction to navigation at that time, and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga by Capt. L. Cooper Overman, Corps of Engineers, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of Chief of Engineers, 1871, pages 502 to 507, and 1872, pages 488 to 494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water, and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements practically permanent, with the exception of the re-

moval from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams.

In 1850 Congress appropriated $50,000 for the improvement of this portion of the river, and the money appropriated was expended under the direction of Col. J. McClellan, topographical engineers, U. S. Army. Some of the dams built under this appropriation are still in existence, though generally covered up by the more extensive work of recent improvements.

The present project of improvement is based upon the examination of 1871, and provides for the removing of snags and drift, and for deepening the channel at the worst obstructions by blasting and dredging or by scouring the bars by the aid of wing dams to an extent that will secure a channel three feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891 for the reasons stated in the reports of those years. Fifteen appropriations have been made by Congress for this work, aggregating the sum of $271,000, viz:

Act of—		Act of—	
July 11, 1870	$35,000	March 3, 1881	$7,000
June 10, 1872	25,000	August 2, 1882	7,000
March 3, 1873	25,000	July 5, 1884	3,000
June 23, 1874	25,000	August 5, 1886	7,500
March 3, 1875	40,000	August 11, 1888	15,000
August 14, 1876	15,000	September 19, 1890	30,000
June 18, 1878	15,000		
March 3, 1879	11,500	Total appropriated	271,000
June 14, 1880	10,000		

The amount expended, including outstanding indebtedness to June 30, 1891, was $253,891,33.

This expenditure has resulted in giving a lengthened season of navigation and an improved channel at twenty-nine of the forty-three obstructions enumerated by Col. Long in his report of an examination made in 1830.

Operations have consisted generally of excavating rock and gravel from the channel and building stone dams where necessary to give increased depth over reefs and shoals. It is reported that the work done at White Creek Shoals was rendered specially advantageous by the extension to a length of 1,585 feet of the longitudinal dam built several years ago, and the construction of a second spur dam, 215 feet long (a spur dam 130 feet long was built in 1890), thus causing the removal of the sand bar to deep water, "and it is believed that it is not likely to reform for many years in the navigable channel."

The act of September 19, 1890, provides for—

> Making a careful and comprehensive survey of said (Tennessee) river from Chattanooga to the junction of the Holston and French Broad Rivers, with a view of ascertaining to what extent the navigation of the river is capable of improvement and the cost of the same and the preparation of suitable plans therefor.

This survey, in local charge of First Lieut. John Biddle, Corps of Engineers, was begun in May, 1891, and was carried to the vicinity of Concord, Tenn., about 25 miles, by June 30, 1891.

In July of the present fiscal year the work of examining the channel and reefs at Soddy Shoals was continued and preparations made for drilling and blasting the rocky ledges forming the dangerous reefs of the obstruction, which trend obliquely across the channel, having in

view the obtaining of a channel about 80 feet wide at the foot of Soddy Island. The lower dam was calked and repaired and for a distance of 1,600 linear feet was raised. The upper dam at the tow-head, and the spur dam on the reef were also repaired. For this work 76 cubic yards of stone were quarried and 569 cubic yards placed in dams. Also 3 cubic yards of rock and 32 snags were removed from the channel.

In July the United States steamer *McPherson* was furnished with a steam capstan and the hull recalked and painted.

High water greatly interrupted the work during the entire season, and in November it became necessary to suspend active operations.

The instrumental survey of the Upper Tennessee River, in charge of First Lieut. John Biddle, Corps of Engineers, was extended to Chattanooga, Tenn., a total distance of 188.1 miles from the initial point. The work of survey has been connected with the lowest water of the season of 1891, an unusually low stage. The field work of the survey was completed on October 31, 1891. The office work in the preparation of maps of the survey is well advanced whereon to base estimates, plans, and a project for improvement. Report will be rendered as soon as the work above mentioned is completed.

At the close of November, as a measure of economy and safety, the fleet, with other engineer property, pertaining to the Upper Tennessee, Hiawassee, and French Broad rivers was collected and towed by the United States steamer *McPherson* to Chattanooga, and safely anchored above the Hamilton County Bridge, and placed in charge of watchmen. The moorings selected have proved to be good and secure against drift or wind.

There being no probability that the steamer *McPherson* would be required for active operations for several months, she was temporarily transferred on January 26, 1892, with such appliances and outfit as was deemed necessary for her effective service, to Captain (then First Lieutenant) Geo. W. Goethals, Corps of Engineers, for use at "the Suck," Tennessee River below Chattanooga, subject to return when required. The *McPherson* was in charge of Captain Goethals at the close of the present fiscal year,

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1892, was $17,821.80, as follows:

General improvement	$7,077.03
Survey from Chattanooga to junction of the Holston and French Broad rivers	10,744.77
The estimates for improving Tennessee River above Chattanooga amount to	340,000.00
Amount appropriated	271,000.00
Amount expended, including outstanding indebtedness	269,303.10

Money statement.

July 1, 1891, balance unexpended	$19,518.70
June 30, 1892, amount expended during fiscal year	17,675.77
July 1, 1892, balance unexpended	1,842.93
July 1, 1892, outstanding liabilities	146.03
July 1, 1892, balance available	1,696.90
Amount appropriated by act approved July 13, 1892	25,000.00
Amount available for fiscal year ending June 30, 1893	26,696.90
Amount (estimated) required for completion of existing project	44,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	44,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

2. BELOW BEE TREE SHOALS (225 MILES).

Information pertaining to the section of the river below Bee Tree Shoals (Riverton, Ala.) is very limited. In 1864-'65 a reconnaissance of the Tennessee River from Paducah to Florence (225 miles) was made by a party of the United States Coast Survey, the data thus obtained to be for the use of the Mississippi squadron under the command of Acting Rear Admiral S. P. Lee, U. S. Navy. The "notes" pertaining to the map of the survey states that—

The stages of water in the Tennessee may be divided into low, ordinary, and high water. A low stage of water prevails under usual circumstances for three months of the year; a medium or ordinary stage lasts, generally, five months, and a high stage four months.

The average depth of the river at a low stage is, on all the bars, 3½ feet, excepting Duck River Shoal and Big Bend Shoals, on which 6 inches less is found at such a stage. This applies, however, only to the river below Chickasaw. The average depth at a medium stage may be considered 9 feet on the bars. At this stage only the Green Bottom Bar is bare.

Green Bottom Bar, Duck River Shoals, and Big Bend Shoals, above referred to, are distant 88 miles, 108 miles, and 199 miles, respectively, from mouth of river. Chickasaw Settlement, 225 miles, is now known as Riverton, Ala. This section of the river has been heretofore covered by the surveys, estimates, and appropriations for the Tennessee River below Chattanooga, and no allotments have been specially made for the river below Bee Tree Shoals from the allotments of 1868 and 1869 and the appropriations from 1870 to 1890, inclusive, aggregating the sum of $3,683,000.

A survey was completed in December, 1867, from Chattanooga to mouth of the river, and an estimate of $40,000 submitted for removal of obstructions and construction of wing dams below Florence, 255 miles. (Report of Chief of Engineers, 1870, page 389.)

Maj. Walter McFarland, Corps of Engineers, speaking of the Lower Tennessee, in his report on lines of water communication between the Mississippi River and the Atlantic (Report of Chief of Engineers, 1872, page 513), states that—

Descending the river we find that improvements of some kind or other—removing rock or gravel or constructing wing dams in order to straighten or widen the channels or to give them sufficient depth—will be required at the following points, viz, Bear Creek Shoals, Indian Creek, Big Bend Shoals, Diamond Island, Wolf Island, Chalk Bluff, Beech Creek Shoals, Buffalo Shoals, Armstrongs Towhead, Bridge at Johnsonville, Duck River Shoals and Suck, Turkey Island Shoals, White Oak Island, Harrican Island, Leatherwood Shoals, Sandy Island, Panther Creek Island, McCulloughs Bar, Blood River Island, Pentecost Towhead, Widow Reynolds Bar, Grubbs Towhead, Little Chain, and Grand Chain.

In 1878 and 1879 some work was done at Duck River Shoals, 117 miles below Bee Tree Shoals. This shoal is a gravel bar and is subject to considerable change from the action of the current. In 1881, and again in 1890, a small force with a snag boat was employed a short time in each year removing from the channel a large number of snags and overhanging trees. In 1882 the following localities below Rockport, about 4 miles below mouth of Duck River, were reported as requiring improvement: Duck River Suck, Johnsonville, Reynoldsburg Island, Turkey Island, Sandy Island, Little Chain, and Big Chain. It is stated in the Annual Report of the Chief of Engineers, 1891, page 2257, that—

During the last fifteen years the improvement of the river below Bee Tree Shoals, and in fact below Florence, has not received the attention its commerce and naviga-

tion appears to be justly entitled to, owing to the almost imperative necessity of concentrating all efforts and expending all moneys appropriated for the river "below Chattanooga" upon the removal of the main obstruction to navigation. until recently the impassable barrier of the Muscle Shoals. However, during that fifteen years a small amount of work was done, as above stated, below Riverton, foot of Bee Tree Shoals, Alabama:

In 1878 and 1879, in the channel at Duck River Shoals, amounting to	$7,304.95
In 1881 and 1882, snagging, etc	3,373.04
In 1890, snagging, etc	1,365.33
Total below Bee Tree Shoals from 1875 to 1891	12,043.32

For the reasons stated and from information received from various sources it is believed that the condition of the Lower Tennessee demands an accurate survey. The Muscle Shoals Canal, opened to navigation November 10, 1890, and the work now in progress at Colbert Shoals and Bee Tree Shoals, make it very important that the Lower Tennessee River, from the foot of Bee Tree Shoals to the mouth of the river, be put in such condition as to permit the safe passage at all seasons of any boats capable of navigating the Muscle Shoals Canal and the proposed Bee Tree and Colbert Shoals Canal, now in course of construction. In order to accomplish this it will be necessary to have an instrumental survey made of this section as soon as possible, to obtain detailed maps of the obstructions, with a complete profile of the river, so that estimates can be made and project for the radical improvement of the river below Riverton, Ala., be submitted, based upon the necessary and definite data that can only be thus obtained.

If the Tennessee below Bee Tree Shoals is to be radically improved, it is very necessary, as above suggested, that an instrumental survey be made as soon as practicable, for the reason that the surveys, so called, heretofore have been simply rapid reconnaissances or examinations, and do not furnish the data necessary whereon to base an economic, advantageous, and energetic prosecution of any work of improvement that may be projected.

The river and harbor act of September 19, 1890, appropriated for—

Improving Tennessee River below Chattanooga, Tenn., including Colbert Shoals and Bee Tree Shoals: Continuing improvement, $175,000, out of which $25,000 may be used at Livingston Point, at the mouth of said river, in accordance with the recommendation of the engineer in charge of that portion of the river.

The recommendation referred to in the act above cited is contained in House Ex. Doc. No. 172, Fifty-first Congress, first session, containing the report of Lieut. Col. William E. Merrill, Corps of Engineers, concerning improvement of Livingston Point, Ky., which is described in the last Annual Report of the Chief of Engineers, page 2256, as follows:—

Livingston Point.—This is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee rivers, just above the mouth of the latter stream. This point and the two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee, flowing from a southern latitude and rarely if ever troubled by ice.

The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River is rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio has washed through at high water.

A survey of Livingston Point was made in December, 1890, and based upon the data thus obtained a project for its preservation, with an estimate of $180,000, was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of January.

The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush carried well down the bank below the water surface, supplemented by a pile and stone dike

along the crest of the weakest portion of the line, where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which from the present indications is likely to occur.

The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone in alternate layers. From low water to foot of dike broken stone will be carefully placed.

A contract was entered into March 30, 1891, with Mr. William Kirk, of Madison, Ind., for the construction of a part of the pile and stone dike, including the necessary shore protection, the consideration of the contract amounting to $14,555.

Only a small quantity of work was done under this contract during the fiscal year ending June 30, 1891, which consisted of driving 348 piles, placing 55 waling pieces and 62 iron rods in position, and depositing 2,059 cubic yards of stone and 513½ cords of brush in the dike and as bank protection. The amount expended during the fiscal year ending June 30, 1891, including outstanding indebtedness but not including amount pledged by the existing contract, was $1,327.21.

Work was continued during the present fiscal year under the contract of Mr. William Kirk, the contract being completed and terminated on September 23, 1891; the total amount paid under the contract being $21,308.15.

The following was the work done in July, August, and September, and prices paid under the contract, viz:

	Quantity.	Cost.
Piles (35 to 40 feet long) driven	106	$3 each.
Waling pieces ... feet B. M.	8,692	$25 per 1,000 feet B. M.
Rods (iron) ... pounds	6,742½	6 cents per pound.
Stone ... cubic yards	11,372.43	$1.25 per cubic yard.
Brush ... cords	2,684.88	80 cents per cord of 128 cubic feet.

The dike has been completed on the Ohio side across the "washout" near the extremity of the Point for a distance of 660 feet. The bank protection covers a length of 2,330 feet, extending 632 feet above the dike and 1,038 feet below it, the average width being 47 feet.

The plan adopted provides for a double dike, having 20 feet space between the parts but tied together at the top, each section consisting of two rows of piling 10 feet apart.

During the progress of the work it was noted that the Tennessee River was not washing the bank on the Tennessee side to any appreciable extent. Therefore the two rows of piling were omitted on that side, all the work being done on the bank facing the Ohio River so as to protect at once the low part of the exposed strip or "Point," which was in great danger of washing away.

As soon as practicable an examination will be made of the Point to ascertain to what extent the work done has been beneficial, or if any serious injury has resulted from recent floods by erosion above or below the riprap protection on the Ohio bank, or from any other cause.

When further appropriations are made for this work, the funds can be profitably expended under the existing project, subject to such approved modifications as may be found necessary.

The amount expended during the fiscal year was $21,797.34,

Having reference to the bridges spanning the lower Tennessee, of which formal complaint has been made and action taken by the Secretary of War—

1. The removal of the rest piers of the bridge of the Newport News and Mississippi Valley Company at Gilbertsville, Ky., is not completed. By direction of the Secretary of War the rest piers are to be wholly removed to a depth of not less than 6 feet below extreme low-water mark. These piers have been removed nearly to the depth required and the said company reports that it "will remove remainder of pier as soon as water gets low enough so men can work to advantage."

2. The bridge of the Nashville, Chattanooga and St. Louis Railway Company at Johnsonville, Tenn., having been reported upon as an unreasonable obstruction owing to the faulty construction of the draw and the large deposits of stone placed around the piers to strengthen them, an alteration of the obstructing bridge was taken under consideration by the War Department. The said company however proposed to erect a new bridge rather than alter the existing bridge, and submitted plans for a new bridge to replace the present structure, which were approved by the Secretary of War, and the time of completion stated to be on or before November 15, 1894.

No survey has been made of the Tennessee River below Bee Tree Shoals, nor project or estimate submitted for its improvement.

Estimate of cost of preserving Livingston Point, Kentucky	$180,000.00
Amount appropriated	25,000.00
Amount expended	22,964.30

NOTE.—The money statement is included in that for improvement of the Tennessee River below Chattanooga, Appendix C C 1, page 1951.

List of steamboats plying on Tennessee River above Chattanooga.

[Character: stern-wheel.]

Names.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
C. M. Fouche	93	14	2	61.12
Dixie	80	19	3	68.33
Dayton	142	24.7	3.8	195.63
Herbert	134	27	3	167.60
J. R. Hughes	98	17	3	95.15
J. C. Warner	142	31.6	4.6	201.05
J. W. Bussell	76	9	2.8	24.60
Lucile Borden	86	14	2.5	55.32
M. V. Reid	65	24	3.4	65.29
Oliver King	60	8	2	29.30
Pin Hook	94	18	3	90.60
R. C. Gunter	153	28	4	337.30
Rockwood	130	25.6	4	150.52
R. T. Coles	118	24.6	4.2	134.91
Tallassee	60	12	2	22.16
Wyeth City	120	22.5	4	138.96
Walter R. Love	112	18	3.5	80.14
Clinton B. Fisk	100	18	3.4	79.89
Key City	80	15	3.2	59.45
Maud	79	16.5	3.2	23.30
Hattie McDaniel	90.5	18	2.5	90.63
J. P. Kendrick	112	20	3.7	128.71
Ella Durham	37.5	7	3.7	11.14
Vollette	45	8.5	3.1	15.05
Verona	43.2	11	2	6.13
Harriman	30	7.5	4	5.93
John A. Hart	41	7	2.1	5.68

List of steamboats plying on Tennessee River below Bee Tree Shoal (Riverton, Ala).

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
Allen J. Duncan	165		5	319.46
Clyde	181	32.5	5.6	382.96
C. Smith	132	29	3.5	226.39
W. F. Nisbet	200	35	5.5	576.86
City of Paducah	190	32	6	365.58
City of Savannah	186	31	5	335.55
City of Sheffield	180	35	5	329.74
Herbert	134	27.8	3.6	167.60
Wyandot	91	18	3	65.94
Albert S. Willis	152	26	4	132.99
A. Cany	75	14	5	36.77
Corinne	46.5	8.4	4.6	13.39
Corinne No. 2				24.32
Iron Sides	154	30	6	280.80
Iron Age	176	38	6	385.91
Jennie Gilchrist				74.48
Annie Barnes	53	10.7	3	14
Frank Burnett	50.5	9.2	2.8	7.61
Jennie Pearl	53	10.4	4.5	9.13
Pearl of Paducah	61.1	15.5	5.7	18.23
D. O. Brooks	75.5	17	3.5	54.03
Gus Genin	120	20	4	130.09
Mary N	69	14	3	36.40
Ida	80.5	14.8	6.6	37.37
Helene	194	33	4.5	352.31
City of Florence	160	32	5.3	358.31
Charley McDonald	150	30	4.5	259.52
Excel	122	21.5	3.5	118.92
Jennie Campbell	147	28	4.5	225.56
Louis Houck	210	37	6.5	913.27
George Lysle	173	33	6	426.74
Josie	143	28	5	237.51
Eagle	155	24	5	231.30
Hiawatha	141	30	5.5	245
Iron Duke				421

COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, Tenn., from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Iron ore	53,786	Tanbark	352	Chickens	17
Logs	25,000	Iron	350	Straw	10
Sand	19,630	Cattle	222	Tiling	8
Grain	12,344	Cross ties	199	Butter	6
Coal	11,600	Peas	176	Bran	2
Hay	2,775	Shucks	154	Hogs	1
Lumber	1,161	Drain pipe	122	General merchandise	6,900
Building material	1,065	Bricks	54		
Flour	437	Eggs	36		

Number of passengers, 764.

NOTE.—The logs reported reached Chattanooga and were run out of the upper tributaries of the Tennessee River in about the following proportions, viz.:

	Tons.
Powells River	5,000
Emory River	2,000
Little Tennessee River	2,500
Clinch River	12,500
Hiawassee River	3,000

The Loomis & Hart Manufacturing Company, of Chattanooga, who kindly furnish the above information, states that the reason why more logs come to Chattanooga from the Hiawassee River than from the Little Tennessee River is because a large number are stopped at Loudon, Tenn.

Tennessee River below Chattanooga, Tennessee, Alabama, and Kentucky. Below Bee Tree Shoals, Riverton, Alabama. From July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Staves	14,434	Cattle	1,752	Spokes	266
Grain	14,505	Tobacco	1,110	Hay	132
Lumber	26,581	Cotton seed	835	Hogs	160
Logs	8,025	Salt	608	Horses and mules	53
Pig iron	5,120	Sugar	371	Molasses	40
Flour	4,755	Sand	365	Blasting powder	25
Iron	3,680	Cross-ties	262	Vinegar in barrels	24
Cotton	3,498	Bricks	229	Corn husks	10
Peanuts	2,024	Hoop poles	201	General merchandise	34,718

Number of passengers., 6,071

B B 2.

IMPROVEMENT OF HIAWASSEE RIVER, TENNESSEE.

This stream rises in the Blue Ridge, in western North Carolina and northern Georgia, and flowing in a west-northeasterly direction, enters the Tennessee River about 36 miles above Chattanooga and 148 miles below Knoxville. After breaking through the Smoky Mountain range and receiving the waters of the Ocoee, near Columbus, the Hiawassee becomes a stream of good capacity for navigation.

As early as 1830 the State of Tennessee made some minor improvements, but the work was only of temporary advantage. The act of Congress of June 23, 1874, authorized an examination of this river. The examination was made in September, 1874, under the direction of Maj. Walter McFarland, Corps of Engineers. (See Report of Chief of Engineers, 1875, pages 809 to 813.) The principal obstructions were found to be rock reefs, gravel bars, snags, and overhanging trees, and are of the same general character as those on the Upper Tennessee, and the regimen of the river is equally permanent.

The project for the improvement was based on this examination, and consisted in narrowing the waterway at the shoal places by wing dams, and excavating rock reefs and gravel bars, so as to secure a navigable channel 40 feet wide and 2 feet deep at ordinary low water, as high up as Savannah Ford, about 43 miles from mouth of the river.

The original estimate submitted in 1875 was increased from 1878 to 1885, inclusive, to $36,500, which amount has been covered by the ten appropriations made for this improvement, aggregating the sum of $36,500, viz:

Act of—		Act of—	
August 14, 1876	$10,000	July 5, 1884	$2,500
June 18, 1878	10,000	August 5, 1886	2,500
March 3, 1879	3,000	August 11, 1888	1,000
June 14, 1880	3,000	September 19, 1890	1,500
March 3, 1881	1,500		
August 2, 1882	1,500	Total	36,500

No work was done nor expenditures made in fiscal year ending June 30, 1891. The amount expended to June 30, 1891, including outstanding indebtedness, was $34,951.53.

The last Annual Report states that—

> The work done during the past eleven years has resulted in a partial improvement of the lower river, securing an increased depth of channel and the removal of surface obstructions and overhanging trees.

The work was done at different times at the following obstructions: Matthew Shoals, McElrath Shoals, Sivils Shoals, Magills Islands, Blackbird Shoals, Graves Ferry and Shoals, Canefield Reef, Lasters Creek Shoals, Brindley Shoals, Denton Island Shoals, Boyd Shoals, Horseford Shoals, and Gamble Shoals. The Hiawassee is now navigable for steamboats from its mouth to Charleston, 21 miles, during the boating season on the Upper Tennessee River. Above Charleston to Savannah Ford flatboats are used for transportation.

Operations were not resumed until June of the present fiscal year. A working force was organized at Chattanooga, Tenn., and on June 18 and 19 the United States steamer *McPherson* towed the boats and party selected for the work from Chattanooga to Matthew Shoals. It was found that the water had risen and was too high for work in channel or on the dams. A small force was employed in calking and repairing boats, and 65 overhanging trees were cut down or deadened. As soon as the water falls sufficiently the force will be increased and set to work removing part of the main dam (No. 4), extending from the right bank opposite the lower island, in order to distribute the fall. A ringbolt will also be placed in the end of dam (No. 1) at head of the upper island to assist boats in passing the shoals.

The amount expended, including outstanding indebtedness, during the fiscal year ending June 30, 1892, was $425.29. The funds available ($1,161) will be expended in modifying the dams at Matthews Shoals, and in clearing the channel of surface obstructions. The Hiawassee River, in common with other mountain streams, requires that the channel be kept clear of snags, logs, etc., brought down by the annual floods, and it is advisable that provision be made for such work, so that the advantages resulting from previous expenditures be maintained.

Estimate of cost of improving Hiawassee River, Tennessee	$36,500.00
Amount appropriated	36,500.00
Amount expended, including outstanding indebtedness	35,338.78

Money statement.

July 1, 1891, balance unexpended	$1,586.51
June 30, 1892, amount expended during fiscal year	94.24
July 1, 1892, balance unexpended	1,492.27
July 1, 1892, outstanding liabilities	331.05
July 1, 1892, balance available	1,161.22

COMMERCIAL STATISTICS.

Hiawassee River, Tennessee, from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Coal	6,040	Guano	108	Chickens	8
Sand	5,068	Tan bark	175	Cotton	6
Grain	3,347	Shucks	86	Butter	4
Logs	3,000	Lumber	84	Cement	2
Cattle	711	Brick	71	Melons	1
Flour	357	Straw	51	General merchandise	897
Pease	310	Cotton seed	35		
Hay	251	Eggs	16		

Number of passengers, 76.

B B 3.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

The French Broad River—the Tahkeeostee or Racing Water of the Cherokees—is one of the largest tributaries of the Tennessee. This stream has its source in North Carolina on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock, and after a course of 121 miles, unites with the Holston River, 4½ miles above Knoxville, thus forming the Tennessee River.

An appropriation was made by the State of Tennessee about fifty-four years ago for the purpose of improving the rivers of the section then known as the "East Tennessee district," and the improvement of Seven Island Shoals, of the French Broad River, about 30 miles below Danridge, was begun, under direction of commissioners appointed by that State. The State of Tennessee also built some dams above Dandridge, but these, with the exception of a few repaired by the United States in1881, have been removed during the progress of the work under the present project.

An examination was made of the French Broad in Tennessee under authority of act of Congress, July 11, 1870, and the report upon it is to be found in the Report of the Chief of Engineers for 1871, pages 491 to 494. A reëxamination in Tennessee was ordered by Congress in act of March 3, 1875, "from its junction with the Holston at Knoxville, to Leadvale, Tenn." The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale—mouth of the Nolichucky River—a distance of 90 miles, the river is impeded by the surface obstructions usually found in mountain streams. This stretch of river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge, about 50 miles. The fall being only about 1 foot per mile, the channel can be easily improved. From the junction of the Nolichucky River to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slackwater navigation, the fall being 7 feet per mile.

The present project of improving the channel from mouth of river to Leadvale, about 90 miles, consists in removing surface obstructions, cutting down overhanging trees, and building wing dams where necessary, so as to permit the passage of boats drawing 2½ feet during the ordinary low-water season. Under this plan operations have been carried on at the most serious obstructions.

The following appropriations have been made by Congress for improving the French Broad River in Tennessee, viz:

Act of—	
June 14, 1880	$10,000
March 3, 1881	3,500
August 2, 1882	5,000
July 5, 1884	3,500
August 5, 1886	6,000
August 11, 1888	10,000
September 19, 1890	10,000
Total	48,000

The total amount expended to the close of the fiscal year ending June 30, 1891, including outstanding indebtedness, was $41,301.11.

This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish traps, constructing and modifying wing dams, and revetting the banks where necessary.

These ten obstructions, with their distances below Dandridge and the work done at each, is given in the Annual Report of the Chief of Engineers, 1891, pages 2262, 2263.

The improvements made at Seven Islands Shoals during 1889 and 1890 are therein reported as the most important effected on the French Broad River in several years, and have resulted in making this obstruction navigable for steamers at stages of the river when upstream navigation was heretofore impracticable. Capt. Newman, of the steamer *Lucille Borden*, writes that—

> The work at Seven Islands, although not completed, has done much good. Before any work was done here by the United States it usually took a boat from one-half to one and a half days to go through, where now we can go through in forty-five minutes.

At Bryant Shoal the modification and enlargement of the old wing dam and the removal of bowlders from the channel has greatly improved navigation.

Great benefit has resulted from the improvements made at Jumping Moses Shoal, near mouth of the river, its dangerous condition having been greatly modified.

During the present fiscal year operations were carried on only at Bryant Shoals in July and August, and Hanging Rock Shoals from August to November 5, under the efficient local charge of Mr. R. R. Thacher, superintendent. Bryant Shoals are about 15 miles below Dandridge, or 35 miles from mouth of river. As early as 1840 dams were built with a view to lessening the obstruction; the old dams were built up and strengthened in 1881 by using the loose rock found in the river. Subsequently a large bar of river rock and gravel formed at the foot of the shoals, dividing the channel into two chutes, one going around the bar to the north and the other to the south. These chutes ran across the main current, rendering the channel very dangerous and almost impassable at the foot of the shoals. At the mouth of Pigeon River another large gravel bar shut off all navigation during low water. To diminish these obstacles the bar at the foot of the shoals was excavated and two dams constructed, running out from the north bank 260 feet and 182 feet long, respectively; the old dam extending from the foot of McCroskey Island was straightened and made parallel to the main current, then lengthened 50 feet to hold the water upon the shoal. Across the island chute, about 500 feet below the mouth of the Pigeon River, a cutoff dam was built, 306 feet long, submerging the bar complained of, through which the current will soon cut a good chute sufficient for the passage of boats.

At Hanging Rock Shoals, 3 miles below Bryant Shoals, work was begun in August. The channel was changed from the north to the south side of Brabson Island. The new channel was cleared of snags, drift, etc., and some rock excavation was also necessary. This rock was placed in the dams, together with that taken from part of an old fish-trap dam removed.

Eight dams were built—a retaining dam at foot of island 598 feet long, with two spurs jetting towards the new channel 206 feet and 144 feet long, respectively, to divide the fall and guard against the formation of a bar near the foot of the main dam. The north part, 200 feet long, of the old fish-trap dam on the south bank of the island was utilized and 185 feet of dam added in the direction of the new channel. Two dams were built out from the south shore of Brabson Island 185 feet and 189 feet long, respectively. The two dams across the head of the chute, closing the old channel, are 619 and 368 feet long, respectively. The old channel was left open as long as possible, and no deten-

tion of boats resulted from the change. The work is not completed. Some of the dams should be strengthened and two or three more are needed, but available funds being exhausted, the fleet, with other engineer property, was taken to Chattanooga for winter moorings as a measure of economy and safety.

The work during the fiscal year may be summarized as follows:

Quarry stripped	cubic yards	370
Stone quarried and placed in dams	do	3,655
Loose rock from channel and old fish trap placed in dams	do	1,523
Sand and gravel excavated	do	790
Brush cut for dam	do	40
Overhanging trees cut down	number	14
Dams built, containing 6,000 cubic yards of stone	linear feet	3,492

The amount expended during the fiscal year ending June 30, 1892, including outstanding indebtedness, was $8,129.70.

The improvement of the French Broad River, Tennessee, is of vital importance to the inhabitants along its banks, not only by reason of its increasing commerce, but because of its being constantly used as a highway for travel by the people themselves, as is clearly shown by the number of passengers reported as carried by the small steamers plying this stream.

The completion of the existing project of improvement will open a river highway for the transportation of the mineral wealth of the mountains, and will materially aid in the development of the mines in its locality. Marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise make up the commerce of this stream.

Estimate of cost of improving French Broad River, Tennessee, from mouth to Leadvale	$150,000.00
Amount appropriated	48,000.00
Amount expended, including outstanding indebtedness	47,984.24

Money statement.

July 1, 1891, balance unexpended	$8,145.46
June 30, 1892, amount expended during fiscal year	7,956.07
July 1, 1892, balance unexpended	189.39
July 1, 1892, outstanding liabilities	173.63
July 1, 1892, balance available	15.76
Amount appropriated by act approved July 13, 1892*	15,000.00
Amount available for fiscal year ending June 30, 1893	15,015.76
Amount (estimated) required for completion of existing project	88,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

List of steamboats plying on French Broad River.

[Character, stern-wheel.]

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Onega	105	18	....	74
Lucille Borden	86	14	2.5	55.32
Hattie McDaniel	90.5	18	2.5	90.63

*Of which $1,000 may be used in removing bar in Little Pigeon River.

COMMERCIAL STATISTICS.

French Broad River, Tennessee, from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Sand	18,120	Building material	1,410	Hogs	200
Grain and produce	5,784	Hay	555	Fertilizers	113
Lumber	4,637	Flour	459	Wood	44
Marble	3,888	Logs	272	General merchandise	7,641

Number of passengers, 7,200.

B B 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river—about 1,436 square miles—is mountainous and has very meager transportation facilities other than are afforded by the Clinch River during rain tides.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. (See Report of Chief of Engineers, 1876, pages 736 to 747.) An examination of the Clinch River from Nashs Ford, Virginia, to Haynes or Walkers Ferry, Tennessee, a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pages 1864 to 1867.) The obstructions in the channel were found to be rock reefs, sand and gravel bars, snags, and overhanging trees.

The examination made in 1875 form the basis of the present project of improvement, which consists in removing ledges, rock points, gravel bars, bowlders, snags, and overhanging trees, the obstructions common to all mountain streams tributary to the Tennessee River, building riprap dams so as to obtain at ordinary low water a channel depth of 2 feet from the mouth of the river to Clinton, about 70 miles, and 1½ feet from Clinton to Haynes or Walkers Ferry, about 75 miles. Above Walkers Ferry up to the Tennessee State line, 85 miles, the only improvement advisable is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation during "rain tides."

The following appropriations have been made for this improvement:

Act of—	
June 14, 1880	$10,000
March 3, 1881	3,000
August 2, 1882	3,000
July 5, 1884	5,000
August 5, 1886	5,000
August 11, 1888	5,000
September 19, 1890	4,000
Total	35,000

The total amount expended to the close of the fiscal year ending June 30, 1891, including outstanding indebtedness, was $31,964.09, and as stated in the last Annual Report of the Chief of Engineers, page 2265—

The results of the work done in previous years are that the reefs have been reduced, many snags and overhanging trees removed, and several strong, heavy wing and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun. Special advantages are gained at Blacks Shoals and Bletcher Shoals. The improvements have given very general satisfaction to the river men, and the work done is practically permanent. Also, at Cloud Shoals seven dams have been built, and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have materially lessened the dangers to navigation. Above Haynes improvements have been made at Hunters Shoals, Sycamore Shoals, and Hopson Shoals.

At Llewellyn Shoals an instrumental examination was made, some channel work done, two island dams and two wing dams finished, and the third wing dam begun.

During the present fiscal year operations were confined to channel excavation and building dams at Llewellyn Shoals and at Youngs Island Shoals.

These obstructions are described in the last Annual Report of the Chief of Engineers, pages 2265, 2266, as follows:

Llewellyn Shoals are 3 miles above Clinton by land and 10 miles by river. The shoal has a length of 1¾ miles, and the fall, 8.6 feet, is nearly uniform. The width of the river at this shoal is much greater than the average, being from 500 to 600 feet. The bed is composed of ridges of stratified rock with gravel and small bowlders between. On account of the wide channel and rapid current the water upon this shoal is but 12 to 18 inches in low stages, and the rough bottom renders it a very difficult obstruction.

Youngs Island shoal, at foot of Eagle Bend, 1 mile above Clinton, is an obstruction reported as very objectionable to logging interests.

At Youngs Island the objection appears to have been the existence of a chute on each side of the island, obstructed by fish-trap dams and sand bars. The improvements completed at Llewellyn Shoals consist of reducing projecting rocky points, removing snags, sand, and gravel from the channel, completing the wing dams begun last year, and constructing a dam, 190 feet long, about 324 feet below Moores Ferry or Ford.

Safe navigation at these shoals is now reported possible at a stage of water from 1 to 1½ feet lower than before the last season's work was begun.

At Youngs Island the fish-trap dam was taken from the chute south of the island, but sufficient funds were not available for the completion of the dam necessary to confine the water more closely to one channel for the floating of logs to the mills below the island.

The following work was done during July, August, and September at the points above named:

Rock excavation	cubic yards..	544
Sand and gravel	do....	4
Quarry stripped	do....	92
Stone quarried	do....	277
Stone put in dams	do....	875
Snags removed	number..	10
Overhanging trees cut down	do....	3

The amount expended during the fiscal year, including outstanding indebtedness, was $3,472.99.

Having reference to navigation and commerce upon the Lower Clinch River, the last annual report states that—

The section of river below Clinton, a distance of about 70 miles, is practicable for steamboat navigation during the higher stages of the river, and to increase the length

of the season of navigation the present project contemplates the construction of wing dams and other channel work at the most troublesome obstructions. The principal navigation at present consists of logs and zinc ore; immense tracts of uncut timber still remain in the country adjacent to this stream, and will for a long time to come require its channel as a means of transportation. The products of the zinc mines are still brought down in flatboats to the reducing works at Clinton. These ore deposits are reported as being very extensive and practically dependent upon the the river for transportation.

Estimate for improving Clinch River, Tennessee, as modified in 1885	$50,000.00
Amount appropriated	35,000.00
Amount expended, including outstanding indebtedness	34,962.29

Money statement.

July 1, 1891, balance unexpended	$3,510.70
June 30, 1892, amount expended during fiscal year	3,399.15
July 1, 1892, balance unexpended	111.55
July 1, 1892, outstanding liabilities	73.84
July 1, 1892, balance available	37.71
Amount appropriated by act approved July 13, 1892	4,000.00
Amount available for fiscal year ending June 30, 1893	4,037.71
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Clinch River, Tennessee, from July 1, 1891, to June 30, 1892.

	Tons.
Logs	12,500

B B 5.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

The Cumberland River rises in eastern Kentucky, on the western slope of the Cumberland Mountains, flows in a tortuous course of about 688 miles through eastern Kentucky, middle Tennessee, and western Kentucky, and discharges into the Ohio River near Smithland, Ky. From Point Burnside, Ky.—the head of steamboat navigation—to Smithland, Ky., is 205 miles on an air line, while by the way of the Cumberland River the distance is 518 miles; 203 miles being in the State of Kentucky and 315 miles in the State of Tennessee.

From 1830 to 1840 the legislatures of Tennessee and Kentucky made several appropriations for the improvement of the navigation of the Cumberland River, but little benefit to the general condition of the river seems to have been accomplished. The Cumberland Navigation Company was incorporated by the State of Tennessee in 1846 for improving the "navigation of the Cumberland River below the town of Nashville by means of a system of locks and dams, but nothing tangible was done to carry out the proposed improvement.

Congress appropriated $155,000 for improving the river by

Acts of—	
July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

This amount was expended in carrying out the project authorized by act of Congress and based on the survey of Capt. Howard Stanbury.

From 1838 to 1871 no appropriations were made by Congress for improving the Cumberland River.

By act of July 11, 1870, Congress authorized an examination and survey of the Cumberland River. In Reports of the Chief of Engineers, 1871, pages 468 to 485, and 1872, pages 463 to 472, may be found the reports of Maj. Godfrey Weitzel, Corps of Engineers, U. S. Army, giving description of the Cumberland River from the Great Falls of the Cumberland to the mouth of the river at Smithland, Ky. This survey furnished the basis of the project under which the work below Nashville has been done, the original estimates having been increased in 1884 and 1888. From Nashville to Smith Shoals the work was carried on under the project of 1871 until 1887. A survey of the river from the head of Smith Shoals to Nashville was made in 1882 and 1883. (See Report of the Chief of Engineers, 1884, pages 1663 to 1675.) On this survey is based the present project of improvement by locks and dams of the Cumberland River above Nashville. A survey of Smith Shoals made in 1874 (see Report of the Chief of Engineers, 1875, pages 795 to 800) is the basis of the project under which work has been done at that obstruction from 1877 to 1883. A survey of the Falls of the Cumberland River was made in 1878. (See Report of the Chief of Engineers 1879, pages 1279 to 1282.) An examination above the falls was made in 1880. (See Report of the Chief of Engineers, 1881, pages 1854 to 1859.)

Under provisions of act of August 11, 1888, a detailed instrumental survey was made of the "Lower Cumberland River from Nashville to its mouth, to ascertain if necessary to establish locks and dams." (See Report of the Chief of Engineers, 1890, pages 2151 to 2161.)

The fifteen appropriations made by Congress from 1871 to 1890 amount to $1,176,000 and are itemized under the heads of "below Nashville" and "above Nashville."

The obstructions are of a uniform character, consisting of rock ledges, gravel and sand bars, bowlders, snags, overhanging trees, and other surface obstructions.

1. BELOW NASHVILLE (191 MILES).

The Cumberland River is navigable below Nashville for all steamboats plying on it for six months in each year, for boats not drawing over 3 feet from six to eight months, and for boats drawing 16 inches or less for the whole year. In seasons of unusually low water the mouth of the river, at Smithland, Ky., is seriously obstructed by the formation of sand bars. Up to this time the work below Nashville has been carried on under the project of 1872, which, to quote from the original report, is—

To excavate the bars and rock ledges to get an additional depth of water, to contract the water ways in places to get the requisite depth, to remove snags and

bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

The Board of Engineer Officers (see Chief of Engineer's Report, 1888, pages 1626 to 1632) recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600, so as to increase the depth of water on the shoals at the junction of the Cumberland River with the Ohio River. The river and harbor act approved September 19, 1890, provides that $30,000 of the appropriation for improving the Cumberland River below Nashville shall be expended in improving the mouth of the river, thus modifying the present project.

The following appropriations have been made for this section of the river:

Act of—		Act of—	
March 3, 1871	$30,000	August 2, 1882	$15,000
June 10, 1872	20,000	July 5, 1884	7,500
March 3, 1873	25,000	August 5, 1886	12,500
March 3, 1875	25,000	August 11, 1888	10,000
June 18, 1878	45,000	September 19, 1890	40,000
March 3, 1879	40,000		
June 14, 1880	20,000	Total	305,000
March 3, 1881	15,000		

The amount expended to June 30, 1891, including outstanding indebtedness, but not including the amount covered by existing contracts, was $267,257.10, which expenditure resulted in lengthening the season of navigation by giving an increased depth at low water, combined with greater security in the passage of the worst obstructions, improvements more or less complete being effected in the general river at Harpeth Shoals, Palmyra Bar, Elk Creek Shoals, Dover Island, Gatlin Shoals, Race Track Shoals, Shelley Island, Ingram Shoals, Big Eddy Shoals, etc. Rebuilt and refitted United States snag boat *Weitzel* for snagging, etc., in Cumberland River. Contract was entered into March 12, 1891, with Frederick Hartweg of Cincinnati, Ohio, for the construction of a portion of the dike near Smithland, Ky.

During the present fiscal year, on July 17, the snag boat *Weitzel* was transferred from work above Nashville to work in the channel below Nashville, and was thus employed until December, 1891, removing obstructions at more than 100 different places in the channel between Nashville and Iuka, a distance of about 167 miles, including certain work at Harpeth Shoals and Shelley Island especially advantageous to navigation. The work done consisted of—

Snags and sunken logs removed	number..	1,210
Rock removed	cubic yards..	61
Sand and gravel removed	do....	1,050
Wreckage, sunken barge near Eddyville	tons..	15
Overhanging trees cut or deadened	number..	1,139
Old hull of sunken steamer removed at Lower Nashville Island.		

During October the old spur dams at mouth of river and built out from Cumberland Island were shortened so as to increase the width of channel; 300 feet of the upper dam and 215 feet of the lower dam, consisting of old piling, rock, sand, etc., were removed; of the 585 cubic yards of rock taken out, 105 cubic yards were used for riprapping the shore of the island in the vicinity. In August and September, twenty-one (21) buoys or floats were placed on several dams in the channel to mark their location during high water; the buoys were distributed as follows: at Dover Shoals (7), at Gatlin Shoals (5), at Elk Creek Shoals (1), at Race Track Shoals (3), and at Little River Shoals (5). At the

mouth of river, the work of dike construction and shore protection at root of dike was carried on under contract with Mr. Frederick Hartweg, of Cincinnati, Ohio, during the months of August, September, November, and December, 1891, and February and April, 1892. The following work was done during those months:

Piles driven	number..	1,081.00
Stone placed in dike	cubic yards..	8,826.64
Stone placed as shore protection	do....	1,218.81
Brush placed in dike	cords..	1,636.89

Only two days' work was done in February and one day in April; all work under the contract was practically suspended on December 30, 1891, by reason of the long continued high water.

The time for the completion of work under the contract of Mr. F. Hartweg was December 31, 1891, but on December 14, for the reason above stated, the Chief of Engineers approved of the extension of the time for nine (9) months, to October 1, 1892. The price for each class of work under this contract is as follows:

Piles in place	each..	$2.00
Timber in place	per 1,000 feet B. M..	22.50
Stone placed in dike or as shore protection	per cubic yard..	.94
Brush placed in dike or as shore protection	per cord..	.79
Bolts in place	per pound..	.04¼

The total amount expended during the fiscal year, including outstanding indebtedness, but not including the amount pledged by existing contract, was $21,435.69: For general improvement, $7,413.80; for "at mouth of river," $14,021.89.

The Cumberland River is one of the principal tributaries of the Mississippi system and supplies in many cases, both above and below Nashville, the only means of transit between the towns and villages lying along its course. The commerce of the Lower Cumberland consists principally of grain, tobacco, logs, lumber, wood, general merchandise, and passengers.

The project for the radical improvement of the Cumberland River below Nashville, based on the survey of 1889 above referred to, provides for the construction of seven (7) locks and fixed dams between lock No. 1 of the upper series and Big Eddy Shoals, 144½ miles, each lock to be of the same dimensions as those above Nashville, that is, the lock chamber to be 280 feet long and 52 feet wide, the lifts of the proposed locks varying from 8½ to 11½ feet, aggregating a lift of nearly 70 feet. Certain channel work is provided for in the project between Big Eddy Shoals and mouth of the river. The improvement "at mouth of the river" between Smithland and the deep waters of the Ohio is also embraced in this project at a total estimated cost of $2,000,000, of which $150,000 were added in 1888 to the estimates previously submitted. Should this project for the canalization of the lower Cumberland be adopted, the balance of the estimate, $1,850,000, will then be added, subject to the prior approval of the Chief of Engineers. The first lock of the proposed system, having a lift of about 11½ feet, will probably be located about 37 miles below Nashville, at Reids Reef, near the foot of Harpeth Shoals, one of the worst obstructions below Nashville, the records showing that work has been carried on at this obstruction at various times since 1870, and it is still a formidable obstacle to navigation, but its much needed radical improvement would be effected by the construction of the lock and dam as projected.

The balance of the estimate for work under the existing project, as modified, is $193,000, which can be profitably expended under the project, as follows:

For dike and bank protection at mouth of river balance of estimate (Report Chief of Engineers, 1888, page 1631)	$99,600
For protecting bank of Cumberland Island (Report Chief of Engineers 1889, page 1839)	20,400
For removing surface obstructions, channel excavation, construction of wing dams, etc	73,000
Total	193,000

The original estimate of cost of improving Cumberland River below Nashville, as modified, in 1884 and 1888	498,000.00
Amount appropriated	305,000.00
Amount expended, including outstanding indebtedness and amount covered by contract	293,065.61

Money statement.

July 1, 1891, balance unexpended		$38,740.99
June 30, 1892, amount expended during fiscal year		21,278.83
July 1, 1892, balance unexpended		17,462.16
July 1, 1892, outstanding liabilities	$156.86	
July 1, 1892, amount covered by uncompleted contracts	5,370.91	
		5,527.77
July 1, 1892, balance available		11,934.39
Amount appropriated by act approved July 13, 1892		40,000.00
Amount available for fiscal year ending June 30, 1893		51,934.39
Amount (estimated) required for completion of existing project		153,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		153,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

2. ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

The Cumberland River is navigable from Nashville to Point Burnside, Ky., 327 miles, for steamboats drawing not more than 3 feet, from four to six months of each year, and for boats of greater draft from two to three months.

From Nashville to mouth of Caney Fork River (Carthage, 116 miles), the river is navigable for steamboats of $2\frac{1}{2}$ feet draft, from six to eight months, and for those of greater draft four or five months. Steamboats of light draft can ascend to Burksville, 236 miles above Nashville, for from five to seven months, and larger boats four or five months.

The obstructions in the river above Nashville are of the same general character throughout, consisting of ledges, gravel and sand bars, bowlders, snags, overhanging trees, and rapid currents; and of mill dams in the section of the river above the mouth of Jellico Creek. About 50 miles above Burnside, Ky., are the Great Falls of the Cumberland, a vast barrier to navigation, the difference of level between crest and foot of the main fall alone being about 54 feet. Smith Shoals, 10 miles above Burnside, Ky., having a fall of 55 feet in $8\frac{1}{2}$ miles, form the most serious obstacle to navigation below the Great Falls.

The appropriations made by Congress for improving the Cumberland River above Nashville, under the original projects, were divided by years and geographical sections as follows:

Geographical division.	Acts of—							
	Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.	Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	Total.
1. Nashville to Kentucky line	$15,000	$20,000	$13,000	$15,000	$15,000	....	....	$83,000
2. Kentucky line to Smith Shoals	10,000	8,000	6,000	10,000	15,000	....	....	49,000
3. Smith Shoals	25,000	30,000	15,000	20,000	10,000	$15,000	....	115,000
4. Smith Shoals to Falls of Cumberland	2,000	2,000	....	....	....	....	....	4,000
5. Above the mouth of Jellico, Ky	....	....	....	....	10,000	5,000	....	15,000
6. Nashville to Smith Shoals	....	....	....	....	....	30,000	....	30,000
7. Nashville to head of Smith Shoals	....	....	....	....	....	....	$50,000	50,000
Total	52,000	60,000	39,000	45,000	50,000	50,000	50,000	346,000

These appropriations, aggregating the sum of $346,000, have been expended in the several sections as designated, excepting the sum of $5,000 originally appropriated by act of August 2, 1882, for the section "above the mouth of Jellico, Kentucky," but which was made available by act September 19, 1890, for expenditure, and "to be applied to the removal of snags and sand bars in the said Cumberland River above Nashville, Tenn.," and which has been so expended. (Sec. 3, Cumberland River above mouth of the Jellico, Kentucky.)

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel over the worst shoals by excavation, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

The instrumental surveys of 1882 and 1883 (see Report of Chief of Engineers, 1884, page 1663 *et seq.*) furnish the basis of the present project for the radical improvement of the Cumberland River,

FROM NASHVILLE TO THE HEAD OF SMITH SHOALS.

This project provides for the construction of twenty-three locks and dams between Nashville and Burnside, Ky., and of seven locks and two dams at Smith Shoals, using the river itself as a canal, one dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922.

The act of July 5, 1884, appropriated $50,000 and provided that the "improvement shall be made according to the recommendations of Maj. W. R. King, engineer in charge, contained in the letter of the Secretary of War March 15, 1884, Senate Executive Document No. 129, first session, Forty-eighth Congress."

It is provided in said executive document that the dimensions of the seven locks at Smith Shoals are to be "55 feet by 140 feet in the chamber," and the twenty-five locks between Nashville and Burnside, Ky., "should be about 60 feet wide, and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose."

The act of August 5, 1886, specifically provided for this work of can-

alization "with a view to secure in the channel a depth of 4 feet, commencing with the lock at or near the lower island at Nashville." The Board of Engineer Officers constituted to examine and report upon the plan and estimate for this lock (No. 1) recommended a lock of the following dimensions: 280 feet long, 52 feet wide, from 10 to 12 feet lift, with 4 feet of water on lower and 5 feet on upper miter sill. This recommendation was approved by the Chief of Engineers and the Secretary of War. (See Report Chief of Engineers, 1888, page 1622 *et seq.*)

The plans first submitted provided for a lock (No. 1), fixed dam, and abutment of such dam, but upon further consideration by a Board of Engineers it was recommended conditionally and approved that a movable dam be constructed instead of a fixed dam. (See Report Chief of Engineers, 1890, page 2143 *et seq.*) This Board, in a subsequent report dated November 26, 1890 (6793–1890), for reasons therein given, withdrew its former suggestion and recommended the construction of a fixed dam as originally proposed.

The Board of Engineers constituted to examine and report upon the plan and general design of Lock 2 recommended in their report of November 25, 1890 (6727–1890), a lock of 280 feet available length, 52 feet interior width, conforming to the dimensions prescribed for Lock 1, but recommending a depth of 6½ feet of water on the upper miter sill, and thus to provide for a minimum navigation of 6 feet instead of 4 feet, because "this can be done without extra cost" and "is necessary for the economical transportation of coal."

The plan for Lock No. 2, as approved, shows a uniform depth of 6½ feet of water on the sills.

The style of dam being thus determined, new plans for Lock No. 1, providing for a depth of water of 4 feet on the lower and 6½ feet on the upper miter sill, and for a fixed dam and abutment, were submitted to the Chief of Engineers and by him referred to a Board of Engineer Officers, who in their report of April 20, 1891, recommended the plans for approval, the report of the Board being approved by the Secretary of War April 25, 1891, the plan for Lock No. 1 submitted being "almost identical with the * * * plans for Lock No. 2" (see Report Chief of Engineers, 1891, page 2280 *et seq*). Lock No. 1 having a lift of 9 feet, and lock No. 2 a lift of 11 feet.

Locks of larger dimensions having been adopted for the section from Nashville to Burnside, Ky., as a modification of the existing project, it became necessary to revise the estimates submitted in 1882 and 1883, and such revision was made in the Annual Report of the Chief of Engineers, 1891, page 2270, as follows:

Plans and estimates for Locks Nos. 1 and 2 have been prepared and contracts for portions of the work have been made, from which it is now estimated that each lock and dam will cost not less than $250,000. An estimate of the section from Nashville to Point Burnside, provided twenty-three locks be found necessary, amounts to $5,750,000, and to continue the improvement to the head of Smith Shoals, with seven additional locks and dams of equal cost, would amount to $1,750,000 more, or a total of $7,500,000, an increase of the original estimate by $3,422,078, which modification is made and submitted in this report. By increasing the lift of the locks it may be found possible to decrease their number and thus complete the improvement at a reduced cost.

The appropriations made for work under the present project from Nashville to the head of Smith Shoals, are as follows:

Act of—	
August 5, 1886	$75,000
August 11, 1888	200,000
September 19, 1890	250,000
Total	525,000

Based upon the above-named appropriations, four contracts with two supplemental agreements were made and are now in force as hereinafter described, aggregating the sum of $286,072.75.

On September 19, 1888, a contract was entered into with Holmes & Wilk, of Nashville, Tenn., for the construction of a part of the masonry of Lock 1, etc., the consideration of the contract being $57,080. A supplemental agreement or modification of the contract was made August 22, 1891, for additional masonry due to the substitution of masonry in the land wall for natural rock in place, thereby increasing the consideration of the contract to $76,222.25. The time of completion of the contract has been extended to December 31, 1892.

On October 17, 1890, a contract was entered into with Henry F. Holmes, of Nashville, Tenn., for the partial construction and completion of the masonry of Lock 1, the consideration of the contract being $35,490.50. A supplemental agreement or modification of the contract was made October 9, 1891, for additional masonry, due to the change in height of lock walls, resulting from the adoption of a fixed dam instead of a movable dam, thereby increasing the consideration of the contract to $60,741.50. The time of completion of the contract has been extended to December 31, 1893.

On May 30, 1891, a contract was entered into with Holmes & Wilk of Nashville, Tenn., for the construction of the abutment of Dam No. 1, the consideration of the contract being $10,810. The time of completion of the contract has been extended to December 31, 1892.

On February 24, 1891, a contract was entered into with Rich & Holmes, of Nashville, Tenn., for the construction of the masonry of Lock 2, including building of coffer dam and excavation of lock pit, the consideration of the contract being $163,550. The time of completion of work under the contract is August 24, 1892.

The following statement shows the price for each class of work done under the above-named contracts, excepting that for Lock No. 2, the termination of said contract during the progress of the proposed work and in accordance with its terms having been approved by the Secretary of War. No masonry has been laid and but little work done under this contract, which will be terminated and closed at the earliest day practicable and for the reasons hereinafter stated.

Contracts in force, Cumberland River above Nashville, Tenn., at the close of the fiscal year ending June 30, 1892.

No.	Names and address of contractor.	Cofferdam.	Excavation lock pit.		Lock construction, masonry.						
			Earth.	Rock in place.	Backing.	Rock face.	Pointed face.	Bush hammered face.	Quoins.	Coping fine-pointed.	Bolt holes.
	Lock No. 1.	*Per lin. ft.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per lin. ft.*
1	Holmes & Wilk, Nashville, Tenn.	$5.75	$0.50	$1.15	$8.25	$11.00	$12.00	$14.50	$30.00	......	$1.50
2	Henry F. Holmes, Nashville, Tenn.	......	......	......	8.50	11.00	12.00	....	30.00	$16.00	1.50
	Abutment, Dam No. 1.										
3	Holmes & Wilk, Nashville, Tenn.	......	.30	1.25	7.50	10.00	11.00	....	......	......	......

The amount expended to June 30, 1891, including outstanding indebtedness, but not including the amount pledged by existing contracts, was $77,140.45, which has been applied in the examination and purchase of lands for sites of lock-keepers' houses and of locks and dams Nos. 1 and 2; fencing United States lands; advertising, etc., for proposals; part excavation of lock pits and site of abutment; construction of lock-keepers' house, and of cofferdam, Lock No. 1; payments on stone for masonry of lock and abutment, and the contingencies pertaining to the entire work; rebuilding snagboat *Weitzel*, and refitting same with pumping engine, hoisting engine, derrick, mattresses, with attendant barge, etc.; clearing the channel below Burksville of snags and other surface obstructions brought down by the annual floods; reducing rock and gravel bars; extending and repairing riprap dams to maintain the improvements already secured; this channel work being done from August to November, 1888, and from March to May, 1889, each inclusive.

The cost of rebuilding and refitting snagboat *Weitzel*, the pay rolls of snagging parties, and other contingent expenses incident to—

Channel work amount to	$12,212.52
Canalization and contract work, etc	64,927.93
Total to June 30, 1891	77,140.45

During July, August, and June of the present fiscal year, a small amount of snagging, etc., was done in the channel below the mouth of Caney Fork River. This work was carried on by the snagboat *Weitzel* in July, 1891, and June, 1892, and in August by the snagging party that had been employed on the Caney Fork River while dropping down the Cumberland River to moorings near Nashville.

The work consisted of removing 128 snags from the channel and cutting down or deadening 643 overhanging trees at about eighteen or twenty localities between Nashville and Carthage.

The amount expended, $1,547.56, for the above-named channel work and contingencies pertaining thereto was paid for from the appropriation for "Improving Cumberland River above the mouth of Jellico, Ky.," act of August 2, 1882, which was made available for use "above Nashville" under the provisions of the act of September 19, 1890. (See. 3.)

Also, in June, a steam derrick boat and quarter boat were fitted up, and a snagging party organized in Nashville for clearing the channel of the upper river of surface obstructions, and on the 14th of that month the boats and working force were towed up the river by the snag boat *Weitzel* to Orchard Landing, about 250 miles above Nashville. Snagging was begun on June 18 at Orchard Landing, and continued downstream, reaching Neely Shoals, a distance of about 24 miles, at the close of the fiscal year.

The following work was done on this section, viz:

Rock taken from channel	cubic yards..	2
Snags removed	number..	172
Overhanging trees cut down, topped, and deadened	do....	998

Landings cleared at Bakerton and Cheek Landing; a buoy was placed on dam at Willis Creek to locate it at high water.

Channel operations will be continued during the working season of 1892.

Built new quarter boat and calked the hulls of snag boat *Weitzel*, and three barges.

Examinations were made in June of the obstructions at Salt Lick Island, Holliman Island, and Bartlett Shoals, having in view a needed improvement of the channel at those points 177 miles, 183 miles, and 220 miles below Burnside, Ky., respectively.

The following work pertaining to the prosecution of canal construction under contract was also done:

Fitted up a small boat with derrick, drill, and pump, etc., for use of party employed in examinations pertaining to the selection of lock sites, etc. Made survey of upper approach to Lock No. 1 and plotted notes of same; made test borings at site of Lock No. 2; examined land near Buttermilk Shoals for site of Lock No. 3; ran check line of levels from Lock No. 1 to Locks Nos. 2 and 3, and also to Gallatin Landing for selecting site of Lock No. 4; made detached plans of lock masonry, constructed models of lock and abutment of Dam No. 1.

Four contracts, as previously stated, were in force during the fiscal year; two pertaining to Lock 1, one to abutmant of Dam 1, and one to Lock 2. Operations were in progress under these contracts during the first half of the present fiscal year; subject, however, to frequent interruptions. In December work was entirely suspended, except at the quarries, by reason of high water, which continued until the middle of June, 1892. During that month work was resumed on the abutment of Dam No. 1 and will be continued at Lock No. 1 as soon as the water recedes sufficiently to warrant the pumping out of the cofferdam. Only about 37 per cent of each of the estimated quantities of lock and abutment masonry having been laid, it was necessary that the contracts be extended, as previously stated; the work on the abutments to be completed December 31, 1892, and that on the lock December 31, 1893.

The following table shows the total amount of work done under these contracts, and also the work done during the present fiscal year, from July to December, 1891, and in June, 1892.

Excavation.	Lock 1.			Abutment Dam 1.			Lock 2.		
	1889 to 1891.	1892.	Total.	1891.	1892.	Total.	1891.	1892.	Total.
			Cu. yds.			*Cu. yds.*			*Cu. yds.*
Earth	2,507.7	1,427	3,934.7	485	5,093	5,578	3,000	11,949	14,949
Rock	17,835.6	2,030	19,865.6	....	10	10	....	616	616

Masonry.	Lock 1.	Abutment Dam 1.
	Cu. yds.	*Cu. yds.*
Pointed face	845	....
Rock face	615	80
Backing	2,919	327
Bush hammered	28	....
Quoins	40	....
Total	4,447	407

All the masonry was laid during the present fiscal year.
Length of cofferdam Lock 1, 1,134 linear feet. Length of cofferdam Lock 2, 650 linear feet.

Since April 22, 1892, all work in the channel has been under the immediate supervision of First Lieut. John Biddle, Corps of Engineers, and all work under contract in local charge of Mr. J. S. Walker, assistant engineer.

The total amount expended during the present fiscal year, including

outstanding indebtedness but not including the amount pledged by existing contracts, was $66,357.86.

The Board of Engineers of 1887 in its report on this improvement says: "The locks on the Cumberland River are assumed to be specially intended for the development of the coal traffic of the Upper Cumberland." While one member dissented from the recommendation of the Board as to the size of the locks, thinking smaller ones preferable, in giving his reasons for his opinion he also assumes that the requirements of the coal trade should settle the question. He says: "While uniformity is a desirable thing in such matters, I do not think it would be just to those most interested in the development of the coal trade on the Cumberland River to build larger locks than they desire, especially as it would delay and increase the cost of the work."

The act of Congress of September 19, 1890, provided for the expenditure of $50,000 at Smith Shoals, subject to the approval of the Secretary of War. The great coal region on the Cumberland is above those shoals, and it is estimated that the construction of some seven locks at these shoals would connect that region with the Cumberland at Burnside, just at the crossing of the Cincinnati Southern Railroad. Below this point the Cumberland is navigable for at least four months of the year. The building of these seven locks will certainly tend to the development of the coal trade as much as the construction of the same number of locks just above Nashville, and therefore, in view of the language of the last appropriation act, I recommended that the $50,000 be expended as indicated in the act. This recommendation was approved, and a careful survey of the river from the first shoal below Burnside to the head of Smith Shoals will be made, as well as observations made to determine the volume and velocity of the current at the various stages of the river and examination for lock sites, etc. It is proposed when lock sites have been definitely determined to take proper steps for securing the necessary land.

A lock and dam constitute an obstruction to navigation which is only justifiable when their aid to navigation more than counterbalances their injury. The locks alone are no obstruction. The dams should not be built until they are required as an aid to navigation, which will not be until after more than a half dozen locks are built. By this plan the river will be unobstructed with dams until their construction will be an immediate benefit, and for these years the improvement is saved the expense of maintaining lock-keepers and the wear and tear on lock machinery and the dams. It is proposed to prosecute work simultaneously on as many locks as the available funds will permit.

If an appropriation of $500,000 was made for this improvement every other year for the next twenty-eight years its completion could be expected in a little more than thirty years from now. During this thirty years, if nothing is done for the river excepting the building of the locks and dams, navigation instead of being improved will for most of the time be worse than it is to-day. The permanent improvement of the river by locks and dams will benefit the next generation, but in the mean while the present generation should not be overlooked. In my opinion not less than $5,000 a year—and special circumstances may require a larger amount some years—should be expended on this part of the Cumberland River, over 300 miles in length, in building and repairing temporary dams, in snagging, and other necessary work. I do not estimate for this separately, as it is so small compared with the amount that should be appropriated for the improvement.

As Congress has indicated, by its designating $50,000 for starting the work at Smith Shoals, that it desires the work to be carried on there as well as at the locks immediately above Nashville, provided there are no serious engineering objections, it is proposed in the future to prosecute the work from both points at as many locks as the funds available will permit: It would seem better to treat all the locks as one improvement and not to limit a part of the appropriation. It is possible that complications about obtaining a suitable site, or other causes, might leave one portion of the river with more funds than were necessary, while the other part was suffering for lack of money, on account of the appropriation being divided.

Contract was entered into February 24, 1891, with Messrs. Rich & Holmes, of Nashville, Tenn., for building cofferdam, excavating lock pit, and building masonry of Lock No. 2. The time for the completion of this lock was stated to be on or before August 24, 1892. The specifications state that "excavation will be carried 7 feet and probably in places 10 feet below the low-water pool No. 1," and that the foundation "shall be excavated to solid rock. Borings show some irregularities, the average depth of rock below the surface of low water in pool No. 1, at a point close to the dam, being 4 feet, and 300 feet below the dam, 9 feet."

Actual operations establish the fact that solid rock can not be found throughout the lock pit at anything like the depths specified, and as the masonry must not be permitted to rest upon the insecure foundation of rock slabs, loose rock, gravel, sand, clay, etc., existing at the specified depths, it became obligatory that the contract be modified to meet the actual condition and character of the site, it being evident that the contractors could not be required to do the work except in accordance with a supplemental agreement. Such agreement or modification requires the consent of the sureties of the contract. In this case one of the sureties is dead, and the executors of his estate are not willing to grant consent to any modification of the contract of Rich & Holmes.

Under date of May 21, 1892, it was recommended that the contract be terminated under provisions permitting a termination "for sufficient cause" during the life of the contract without liability on the part of the United States upon payment to the contractor for all work done and all material furnished. This recommendation was approved by the Secretary of War June 3, 1892, with instructions to execute supplemental articles covering a termination of the contract under the provisions of the contract. At the close of the fiscal year this matter was in process of adjustment by taking inventory of property and appraising the same. Supplementary articles will be executed as soon as practicable.

When the stage of water permits, a careful examination will be made of the present site, and perhaps other locations, to determine the advisability of continuing the work at the present site or of submitting a new site for approval.

Estimate for improving Cumberland River by locks and dams from Nashville to head of Smith Shoals, as modified in 1891	$7,500,000.00
Amount appropriated	525,000.00
Amount expended, including outstanding indebtedness and amounts covered by contracts	363,921.79

Money statement.

July 1, 1891, balance unexpended		$448,318.60
June 30, 1892, amount expended during fiscal year		64,901.49
July 1, 1892, balance unexpended		383,417.11
July 1, 1892, outstanding liabilities	$1,456.37	
July 1, 1892, amount covered by uncompleted contracts	220,882.53	
		222,338.90
July 1, 1892, balance available		161,078.21
Amount appropriated by act approved July 13, 1892		250,000.00
Amount available for fiscal year ending June 30, 1893		411,078.21
Amount (estimated) required for completion of existing project		6,725,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1894		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

3. CUMBERLAND RIVER, ABOVE MOUTH OF THE JELLICO, KENTUCKY.

Two appropriations have been made for this section of the river, aggregating the sum of $15,000, viz:

Act of—

March 3, 1881	$10,000
August 2, 1882	5,000

No work has been done since 1882. The appropriation of $5,000, made by act of August 2, 1882, and held over and unexpended, was made available by the act of September 19, 1890, for expenditure, and to be "applied to the removal of snags and sand bars in the said Cumberland River, above Nashville, Tenn."

The sum of $4,922.02 has been so expended. In 1891, $3,374.46, and in present fiscal year, $1,547.56. For work done see "2. Above Nashville."

Money statement.

July 1, 1891, balance unexpended	$1,625.54
June 30, 1892, amount expended during fiscal year	1,547.56
July 1, 1892, balance unexpended	77.98

List of steamboats (stern wheel) plying on Cumberland River below Nashville.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
Charles A. Blackman	61	18	3.6	25.20
J. P. Drouillard	165	31	5	467.17
A. Frank	98	18	4	70.56
D. A. Goodin	103.6	23.3	3	69
Alex. Perry	149.9	28.5	3.5	172.76
B. S. Rhea	165	27	4.6	203.77
J. R. Skiles	68	17.9	3.1	41.43
John Orm, No. 3	95	17	3.5	95.33

List of steamboats (stern wheel) plying on Cumberland River above Nashville.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
John T. Carson	85	18.8	3	47.60
A. Frank	98	18	4	70.56
John Fowler	140.5	20	3.5	237.89
J. W. Hart	168	29	3	215.97
E. T Holman	100	20	3	71.50
Pearl	140	22	2.7	73.98
J. J. Odil	149.5	28.5	3	172.76
I. T. Rhea	149.8	30.4	3.9	198.54
John Orm, No. 3	95	17	3.5	95.33

Cumberland River, above Nashville, between Burnside, Ky., and Butler Landing, Tenn., distance 143 miles.

Stern-wheel steamers.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Clayton H. Webb	110	25	3	99.98
Crescent	80	16	3	34.54

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Wood	15,625	Cattle	1,500	Hogs	600
Grain	11,633	Horses and mules	1,500	Shingles	225
Lumber	9,700	Salt	780	Iron	200
Bricks	6,565	Flour	700	Hay	150
Tobacco	4,000	Coal	700	General merchandise	25,000

Number of passengers, 15,000.

Cumberland River above Nashville, Tenn., from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.	Articles.	Tons.
Sand	14,900	Cross-ties	1,633	Coal	898
Lumber	14,700	Tobacco	1,620	Sheep	500
Staves	9,900	Horses and mules	1,423	Bricks	250
Grain	4,922	Wood	1,325	Hay	195
Cattle	3,018	Hogs	1,291	Shingles	150
Salt	1,988	Logs	1,125	Iron	100
Spokes	1,900	Flour	928	General merchandise	20,125

Number of passengers, 22,000.

Cumberland River above Nashville, Tenn.; above Burnside-Smiths Shoals, from July 1, 1891, to June 30, 1892.

Articles.	Tons.	Articles.	Tons.
Coal	500	Staves	100
Logs	11,250	Cedar logs	645
Cross-ties	4,375	Cedar posts	844

B B 6.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream rises in the plateau of the Cumberland Mountains, in Cumberland County, Tenn., and discharges into the Cumberland River at Carthage, about 116 miles above Nashville. The Caney Fork River, about 200 miles long and having its course and watershed wholly in Tennessee, is navigable to Frank Ferry, about 92 miles from its mouth.

Under provisions of act of Congress approved June 18, 1878, an examination was made in February, 1879, from the mouth of the river to Sligo Ford, 72 miles. (See Report of Chief of Engineers, 1879, pages 1275–1277.) In compliance with provisions of act of Congress approved July 5, 1884, the examinations of 1879 was extended in 1886 from Sligo Ford to Frank Ferry, a distance of 20 miles. (See Report of Chief of Engineers, 1887, pages 1768–1771.) The channel was found to be obstructed by rock reefs, sand and gravel bars, snags, and overhanging trees.

The fall from Frank Ferry to mouth of the river, 92 miles, is estimated to be about 132½ feet.

The present project, based on the data obtained during these examinations, is to improve the 92 miles of river from Frank Ferry to its mouth by removing the surface obstructions brought down by the annual floods and building necessary riprap dams and training walls, so as to obtain sufficient water for safe navigation for steamboats drawing not more than 3 feet during the usual boating season of about five months, from February to July.

The following appropriations have been made for this work by acts of Congress, viz:

Act of—	
June 14, 1880	$6,000
March 3, 1881	4,000
August 2, 1882	4,000
July 5, 1884	3,000
August 5, 1886	3,000
August 11, 1888	2,500
September 19, 1890	2,500
Total	25,000

The amount expended to June 30, 1891, including outstanding indebtedness was $23,353.49, which was used in removing snags brought down by the annual floods, cutting overhanging trees, reducing gravel and sand bars, in repairing and building wing-dams, and has resulted in greatly improving the channel from Frank Ferry to Mine Lick Shoals when the river is at a 3-foot stage above low water, especially at the obstructions known as Chandler Island Shoals and Trousdale Ferry.

Active operations in channel were in progress at the close of the last fiscal year, and were continued during this year from Mine Lick Island to mouth of the river, at Carthage, Tenn., removing 30 cubic yards rock, 227 snags, and 5,969 overhanging trees at thirty-one different localities in the distance of about 60 miles. The excellent work done in clearing the channel will be of great advantage to the rafts and flatboats coming down on the so-called rain tides. Work was suspended in August, 1891, the appropriation being nearly exhausted. The property pertaining to this work was moved down the Cumberland River to Nashville and placed in charge of watchmen, with other engineer property, as a measure of economy and safety.

The amount expended during the fiscal year, including outstanding indebtedness, was $2,501.86.

A small outlay is absolutely necessary in each year to maintain the channel in the safe navigable condition existing in August, 1891, for the removal of snags, drift, and other surface obstructions brought down by the annual floods, as is common to the mountain streams of this section.

The commerce of the Caney Fork River during this fiscal year has materially increased; three small steamboats, with an aggregate tonnage of 419½ net tons, having plied at irregular intervals upon this stream. The greater part of the commerce, however, has consisted, as heretofore, of logs and lumber in rafts, but the merchants state that rafts reach them made of logs from the Cumberland River and its several tributaries, and that they have no means whereby to report separately the number of logs or rafts received from the Caney Fork River.

Estimate for improving Caney Fork River from its mouth to Frank Ferry	$45,228.00
Amount appropriated	25,000.00
Amount expended, including outstanding liabilities	24,966.62

Money statement.

July 1, 1891, balance unexpended	$2,535.24
June 30, 1892, amount expended during fiscal year	2,481.86
July 1, 1892, balance unexpended	53.38
July 1, 1892 outstanding liabilities	20.00
July 1, 1892, balance available	33.38
Amount (estimated) required for completion of existing project	20,228.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	20,228.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

List of steamboats (stern wheel) plying on Caney Fork River.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Net.*
Alex. Perry	149.9	28.5	3.5	172.76
Pearl	140.0	22.0	2.7	73.98
J. J. Odil	149.5	28.5	3.0	172.76

COMMERCIAL STATISTICS.

Caney Fork River, Tennessee, from July 1, 1891, to June 30, 1892.

Articles.	Tons.
Grain	56
Salt	70

Number of passengers, 10.

B B 7.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

The South Fork of Cumberland River is formed by the junction of Clear Fork and New River in Scott County, Tenn. From the point of union the river takes a northerly course of about 88 miles, 35 miles in Tennessee and 53 miles in Kentucky, entering the Cumberland River near Burnside, Ky., about 2 miles below Smith Shoals.

An examination was made in the winter of 1880, under the provisions of the river and harbor act of June 14, 1880. It was then found that the South Fork could not be navigated on its upper waters, owing to the great sandstone bowlders that obstructed the narrow rapid channel. Its lower course from Devils Jumps to mouth of river, a distance of 44 miles, was found to be seriously obstructed by gravel and sand bars, rock reefs, and surface obstructions, similar in character to other mountain streams in this vicinity. It was, however, deemed feasible to reduce the reefs and bars, clear the channel of snags, drift, and overhanging trees, and by the use of wing dams to contract and deepen the channel.

The original project consisted in thus clearing and deepening the navigable channel in Kentucky from the State line to mouth of river, so as to obtain a safe channel for the passage of rafts and flatboats at a stage of the river not lower than 3 feet above average low water. Work has been limited to the section of river below Devils Jumps, a distance of 43.6 miles, with a fall of 134 feet; 58 feet in the upper 12.6 miles and 76 feet in the lower 31 miles of river.

The following appropriations have been made for this work by acts of Congress, viz:

August 2, 1882	$3,000
July 5, 1884	4,000
August 5, 1886	5,000
Total	12,000

The amount expended to June 30, 1891, including outstanding liabilities, was $11,968.94, which was used principally at Sloan Shoals, and Roberts Mill Shoals, improving the channel and securing safer navigation for rafts and flat boats, for a distance of about 16 miles above the mouth of river. No work has been done on this stream since September, 1887, and no expenditures were made during the fiscal year ending June 30, 1892.

The Burnside and Nashville Packet Company reports that because of the unfavorable condition of the channel no steamboats have ventured up during this fiscal year though urgently requested to do so, but that the work done by the Government has caused the residents to clear up the tributary streams, thus largely increasing the rafting interests.

When slackwater navigation is secured at Burnside under the approved project for the canalization of the upper Cumberland River, it will necessarily give a sufficient depth for navigation for several miles up the South Fork.

Estimates for improving South Fork of Cumberland River, Kentucky.

From Kentucky line to Devils Jumps	$27,538.00
From Devils Jumps to mouth of river	35,265.00
Total estimate	62,803.00
Amount appropriated	12,000.00
Amount expended, including outstanding liabilities	11,968.94

Money statement.

July 1, 1891, balance unexpended	$41.03
July 1, 1892, balance unexpended	41.03
July 1, 1892, outstanding liabilities	9.97
July 1, 1892, balance available	31.06
Amount (estimated) required for completion of existing project	50,803.00
Amount that can be profitably expended in fiscal year ending June 30, 1894	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

South Fork of Cumberland River, Kentucky, From July 1, 1891, to June 30, 1892.

Articles.	Tons.
Logs	39,198
Staves	233
Cross-ties	7,001
Cedar posts	921
Lumber	50

APPENDIX C C.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA.

REPORT OF CAPTAIN GEO. W. GOETHALS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1892, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Tennessee River between Chattanooga, Tennessee, and foot of Bee Tree Shoals, Alabama.
2. Operating and care of Muscle Shoals Canal, Tennessee River.

ENGINEER OFFICE, U. S. ARMY,
Florence, Ala., July 7, 1892.

GENERAL: I have the honor to transmit herewith annual reports for the works of improvement in my charge for the fiscal year ending June 30, 1892.

* * * * * * *

Very respectfully, your obedient servant,

GEO. W. GOETHALS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF TENNESSEE RIVER BETWEEN CHATTANOOGA, TENNESSEE, AND FOOT OF BEE TREE SHOALS, ALABAMA (260 MILES).

The report on this portion of the river is subdivided to agree with the allotments of the appropriation for improving Tennessee River below Chattanooga, Tenn., act of September 19, 1890, as follows:

1. Chattanooga, Tenn., to Decatur, Ala. (180 miles).
2. Decatur, Ala., to Florence, Ala. (50 miles).
3. Florence. Ala., to the foot of Bee Tree Shoals (30 miles).

1. CHATTANOOGA, TENNESSEE, TO DECATUR, ALABAMA.

The most serious obstructions in this section of the river are Ross Towhead, Burris Bar, "The Suck," the reefs near Bridgeport, Ala., Widow Bar, and Guntersville Bar.

Ross Towhead.—This divides the river, about 1 mile below Chattanooga, into two portions; the right chute, generally used during the medium and higher water stages, is not navigable during low water, because of rock ledges extending across to the towhead. The left chute was selected for navigation, and, to increase the depth of water, two riprap dams were built in 1873–'74; one extends from the head, about two-thirds across to the right bank; the other, from the foot of the towhead, downstream for a distance of 400 feet. Gravel washed out from above has accumulated at the foot of the longitudinal dam, until at present a gravel bar connects its extremity with the left bank; about 18 inches is the available depth at extreme low water.

Burris Bar.—Williams Island, about 7 miles below Chattanooga, divides the river, the present low-water channel being to the right of the island. This channel is obstructed by Burris Bar, consisting of ledges of rock, entirely across the channel; the bar is about 1,800 feet in length and the available depth, at extreme low-water mark, is about 1 foot. The left channel is obstructed by a short reef at the head, and by snags and bowlders. No work of improvement has been done here.

"*The Suck.*"—"The Suck" is the name commonly applied to the several rapids and shoals where the river winds in a tortuous route through the mountains below Chattanooga, covering a distance of 8.5 miles, in which the fall is 16.5 feet. The obstructions, separated by pools, are known as Tumbling Shoals, the Suck, the Pot, the Skillet, and the Pan, and are formed by rock reefs and bowlders, and by projecting rocky points from both shores, which contract the waterway. At low-water stages Tumbling Shoals and the Skillet are especially difficult to navigate; as the river rises, the Suck, including Suck Point, becomes difficult to stem, while the Pot and the Pan are very great obstructions during the high stages.

The channel work carried on in 1869 and 1870 at the Suck and the Pot, and in 1889 at the Pan, consisted in widening the cross section by the removal of bowlders, projecting rocky points, and overhanging trees, and has resulted in somewhat diminishing the velocity of the current, but upstream navigation is still attended with delays caused by the necessity of laying lines and warping vessels over the swiftest places.

Bridgeport Bars.—There are three bars in the vicinity of Bridgeport, Ala., any one of which is an obstruction to navigation. The river at this locality is divided by Bridgeport Island, the channel on the left being the steamboat route. Near the head of the island is the first rock reef, about 700 feet in length, on which there is a minimum depth of 1 foot at extreme low water. The second obstruction is just above the railroad bridge, also rock ledges, about 1,100 feet in length, with depth of water at lowest stage of 18 inches; this depth covers the third rock reef, near the foot of the island, which is 1,400 feet in length.

Widow Bar.—This obstruction, another rock reef, is about 2.5 miles below Bridgeport Island, and is about 2,800 feet in length, the depth of water varying from 1.5 to 2.5 feet.

Guntersville Bar.—The river just above Guntersville is obstructed by bowlders and loose, detached rock, which makes the steamboat channel very crooked and difficult of passage during low-water stages,

and by a rock ledge, 300 feet long, on which there is a minimum depth of 1 foot of water.

Other obstructions of minor importance exist between Guntersville and Decatur, but their exact nature and extent is not known, as a survey of this portion of the river has never been made.

The approved project for this section of the river is "to remove obstructions, so as to secure a depth of at least 3 feet at low water," and $50,000 of the appropriation of September 19, 1890, was allotted "to be expended in removing bowlders by blasting, cutting trees from the banks, and dredging at and between the localities known as Tumbling Shoals, Suck, Pot, and Skillet, in the mountains below Chattanooga, and in channel excavation at Bridgeport and Guntersville, Ala."

The following work has been done during the past fiscal year: The survey, begun in May, 1891, was completed to Kelly Ferry, about 23 miles below Chattanooga; surveys were made of the Bridgeport, Widow and Guntersville bars; total length of surveys, 32 miles. The maps of all the obstructions have been platted.

After the completion of the survey, a working party was organized, and work at Tumbling Shoals and Suck Point begun. At the former locality, the channel immediately below was considerably straightened by the removal of obstructing bowlders at Poor Horse and Broad Axe Bars, and though rock excavation was attempted in the channel at the shoals, with a view of increasing the depth and of distributing the fall over a greater distance, high water stopped the work and but little could be accomplished.

From the head of Tumbling Shoals to the head of the Suck the large bowlders along the bank, together with the timber up to high-water mark, were removed by blasting and cutting, to facilitate discharge at the medium and higher water stages. Eight thousand and eighty-three cubic yards of rock and 3,793 trees were removed.

Under advertisement and specifications, dated November 10, 1891, bids were opened November 30, 1891, as follows:

Abstract of proposals for removing rock at and near Gunter Reef, Tennessee River, Alabama, opened at Engineer Office, U. S. Army, Florence, Alabama, Monday, November 30, 1891.

No.	Name and address of bidder.	Rate per ton.	Total for 1,600 tons.	Remarks.
1	B. G. Bailey, Atlantic City, N. J.	$4.90	$7,840	Exceeds available amount.
2	Neely & Smith, Chattanooga, Tenn	1.75	2,800	Lowest bid.

A contract was entered into December 11 with Neely & Smith, of Chattanooga, Tenn., the lowest bidders, for excavating a channel 150 feet wide through the reef at Guntersville and for the removal of obstructing bowlders near the head of Henry Island. The contractors prepared the necessary plant for commencing the work, but the river rose and has not been sufficiently low since to enable the work to be done.

During the year liabilities to the amount of $39,049.62 were incurred, leaving an available balance of the allotment for this part of the work of $8,431.14, out of which the contract for removing bowlders, etc., at and near Gunter Reef, about $4,000, is to be paid.

For further details of work done attention is invited to appended report of Mr. D. L. Sublett, assistant engineer.

2. DECATUR, ALABAMA, TO FLORENCE, ALABAMA.

The principal obstructions are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence, a distance of 38 miles, only 8 of which are navigable, and embracing Elk River Shoals, Big Muscle and Little Muscle Shoals.

The object of the improvement is to make continuous navigation around these obstructions by means of a lateral canal.

The approved project, according to which work is being done, based upon the survey of 1872, and somewhat modified in 1857, is:

(1) To enlarge, rebuild, and straighten the old canal around Big Muscle Shoals, built by the State of Alabama in 1831-'36, and abandoned in 1837, by constructing a canal 14.5 miles long, having nine locks, with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, and having a depth of 5 feet of water on the miter sills.

(2) To construct at Elk River Shoals a canal 1.5 miles long, with two locks, having lifts of 12 feet and from 5 to 9 feet, respectively, and of same dimensions as the locks at Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed rock of the river, and to construct stone wing dams and retaining walls to contract the waterway and to check the velocity of the current at certain points; as modified in 1890: to construct a lateral canal on the north bank 15,000 feet long, with a guard lock at the head and a lock at the foot, having a lift of 12 feet, and of same dimensions as the lock at Big Muscle Shoals.

During the fiscal year the following work has been done:

Elk River Division.—For the purpose of determining the amount of excavation necessary to make the new channel along the left bank, a survey from Browns Ferry to Lock A was begun; the transit and level lines were run, but the soundings were interrupted by high water; the field work was platted.

The drift sluice built in the longitudinal dam which forms the basin above Lock A was completed, and by this means the basin was kept comparatively free from accumulations of drift that had hitherto been a great source of trouble. The sluice is opened and closed by means of the Parker automatic gate. After the completion of this gate, the uncompleted portion of the longitudinal dam, consisting of a gap 650 feet long in the tow-heads opposite Milton Bluff, was finished up to grade and all breaks made during high water were repaired; 1,510 cubic yards of broken stone were placed along the inner slope of the dam to stop leaks.

Lock-keepers' houses were built on the Government lands at locks A and B. Several small ditches were cut in the bottoms, on each side of the canal, for the purpose of draining the sloughs.

Below Lock B work of deepening and widening the channel was continued by dredging and blasting; about 20,500 cubic yards were excavated and formed into an embankment on either side of the channel. At Nance Reef all loose rock was removed and the reef blasted, so as to give at extreme low water a depth of 2.5 feet. With the excavated material a training wall was built along the left side of the cut to deflect the strong cross current that existed during low-water stages. Buoys

were placed from Gilchrist Chute to the foot of Nance Reef, to mark the channel to be followed by steamboats.

Muscle Shoals Division.—The gap at the inner end of the wing dam at the head of the canal was closed.

The work of rebuilding the railway along the towpath was continued and about 4.75 miles built during the year, completing the track from the head to the foot of this division. The track is well ballasted with broken stone throughout, and a new 40-pound steel rail is used on the side nearest the canal. The bridges along the line were strengthened by lateral bracing; the bridges across Blue Water and Shoal Creeks, being unsafe for the new locomotives in use, the former was strengthened by placing intermediate trestles, thus reducing the length of the spans, while the latter was replaced by a new one, composed of 20-inch I beams with lateral bracing.

The quarrying and crushing of stone at the Lock 4 quarry was continued; the product was used in ballasting the track, and also placed along the inner slope of the canal embankment to stop leaks and to protect the slope against wash by waves from passing boats. About 4.5 miles had been thus protected by March 1, when the work was suspended, due to lack of funds.

The lockkeeper's house at Lock 1 was completed, and houses were built during the year at locks 2, 3, 4, 5, and 6; the house at Lock 9 is finished, except interior carpenter work on lower floor, and painting. In addition to the foregoing, assistant lock-keepers' houses were built at locks 3, 6, and 9, and a house for the storage and protection of property was built at Lock 6. Cisterms were built near the houses at locks 1, 2, 3, 4, and 5.

Ditches were dug in the bottoms along the canal to drain the sloughs.

A survey of the canal was made from Lock 2 to Lock 4, this being the portion that is to be widened and straightened, should commerce warrant it.

Land for sites for lock-keepers' houses was purchased at locks 5 and 9; 20 acres of land at the mouth of Second Creek, damaged by overflow when the canal trunk is filled with water, were also bought.

The contracts with A. R. Perry, of Chattanooga, for the construction of a dredge hull, and with the Steam Shovel and Dredge Company, of Bucyrus, Ohio, for machinery for same, were completed, and the dredge was put in successful operation.

The contract with Ed. J. Howard, of Jeffersonville, Ind., for the construction of a light-draft towboat, has been completed. The boat has been used to carry supplies from Chattanooga, Decatur, and Florence to both divisions of the canal, and from the canal and Florence to Riverton, Ala., and also for carrying funds for the payment of employés.

For details of work done on the two divisions of the canal attention is invited to appended reports of Mr. W. G. Williamson and Mr. W. A. McFarland, assistant engineers, in local charge.

Little Muscle Shoals.—The improvement under the modified project of 1877, as above, has been practically completed by cutting a channel 2.5 miles long through the bed rock and building some 3 miles of riprap wing dams. The results obtained are not satisfactory, and the project was accordingly modified in 1890, as before stated.

No work was done under the modified project during the year. Five buoys were placed to mark the right of the channel to be followed by steamboats.

During the fiscal year $124,866.64 were expended, including outstanding liabilities.

3. FLORENCE, ALABAMA, TO THE FOOT OF BEE TREE SHOALS.

Colbert and Bee Tree shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during the low-water stages. These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, and at this stage the depth in the channel is about 1.5 feet. Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams, which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The project, adopted in 1890, contemplates the construction of a lateral canal on the south bank of the river, 7.8 miles long, 150 feet wide at the water surface, with a depth of 7 feet. A combined lock, with a total lift of 25 feet, was originally intended to be placed at the lower end and a guard lock at the head for use when necessary at very high water, the locks to be 80 by 350 feet, with a depth of 6 feet of water on the miter sills at extreme low water.

This project was modified after the detailed surveys of 1891 were completed by substituting for the combined lock two locks of 12 and 13 feet lift, respectively, at extreme low water, and separated by a pool 1 mile in length.

The survey, begun in May, 1891, was completed, and the proposed canal was located and staked out; the center line was determined after an accurate topographical knowledge of the ground was obtained from the preliminary lines run to include the entire bottom. The section lines were also noted. A complete topographical map of the route was made, and from this the estimates for the construction of the canal were based.

With the approval of the Secretary of War negotiations were entered into for the purchase of the necessary land, so that work might be commenced on the construction of the lowest lock. Satisfactory agreements have been concluded for the purchase of 269.66 acres of the total 309.07 acres required, and the matter has been referred to the Department of Justice for examination of titles and preparation of deeds. As these examinations have not yet been completed, no work of construction could be done.

As soon as the spring freshets subsided the center line was marked by monuments and referred to bench marks. In order to ascertain the exact character of rock for lock foundations, test pits were sunk at the proposed gate abutments; but one of these reached rock at the close of the fiscal year, and the rock was examined to a depth of 4 feet; in another, rock was found by the drills.

Authority has been granted to expend $3,500 in removing a few rocks that obstruct the present channel and in repairing the break at the junction of the longitudinal dam and Colbert Island. Nothing was done, as the water remained too high to obtain satisfactory results.

A survey was completed from Florence to the head of Colbert Shoals, a distance of 21 miles, and detailed examinations were made at Tuscumbia Bar and other reported obstructions below. The field notes were platted.

Of the $150,000 allotted for this section of the river, $30,646.67 were expended during the fiscal year, including outstanding liabilities, of which nearly $15,000 is for purchase of land.

Appropriations for improving the Tennessee River below Chattanooga, including surveys, have been made as follows:

March 2, 1827	$200.00
August 30, 1852	50,000.00
June 9, 1860	1,350.00
June 12, 1860	1,406.94
March 3, 1871	80,000.00
June 10, 1872	50,000.00
March 3, 1873	100,000.00
June 23, 1874	100,000.00
March 3, 1875	360,000.00
August 14, 1876	255,000.00
June 18, 1878	300,000.00
March 3, 1879	210,000.00
June 14, 1880	300,000.00
March 3, 1881	250,000.00
August 2, 1882	250,000.00
July 5, 1884	350,000.00
August 5, 1886	262,500.00
August 11, 1888	250,000.00
September 19, 1890	450,000.00
Total	3,620,456.94

The money statement for this work is consolidated with that for Tennessee River below Bee Tree Shoals (Appendix B B 1), so as to embrace the entire reach of the river below Chattanooga, as follows:

TENNESSEE RIVER BELOW CHATTANOOGA, TENNESSEE.

Money statement.

July 1, 1891, balance unexpended		$349,885.56
June 30, 1892, amount expended during fiscal year		196,495.95
July 1, 1892, balance unexpended		153,389.61
July 1, 1892, outstanding liabilities	$19,864.32	
July 1, 1892, amount covered by uncompleted contracts	2,800.00	
		22,664.32
July 1, 1892, balance available		130,725.29
Amount appropriated by act approved July 13, 1892		500,000.00
Amount available for fiscal year ending June 30, 1893		630,725.29
Amount (estimated) required for completion of existing project		5,837,939.81
Amount that can be profitably expended in fiscal year ending June 30, 1894		2,155,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. D. L. SUBLETT, ASSISTANT ENGINEER.

Statement of work done during the fiscal year ending June 30, 1892, on the Tennessee River between Chattanooga, Tenn., and Decatur, Ala.:

At the close of the last fiscal year the survey of that portion of the river embraced between Chattanooga and Shellmound had reached the head of Suck Point, about 11 miles below Chattanooga, but owing to unfavorable stage of the river no soundings of importance had been taken. On July 2, the river having fallen, the survey was pushed to completion at Kelly Ferry, a distance of 22.7 miles, though the examination of the river was continued to Shellmound.

The party was transferred to Bridgeport, Widow Bar, and Guntersville, and made detailed surveys of these obstructions; distances covered were as follows: Bridgeport survey 4.86 miles, Widow Bar 0.58 miles, Guntersville 3.82 miles.

A line of levels was run from the end of the Suck survey to Bridgeport to connect the surveys. This gave a continuous line of levels from Chattanooga to Widow Bar, about 60 miles.

As the stage of the river at the time of the survey at Guntersville was unfavorable for the obtaining of reliable information, after the river had reached a very low stage closer examinations were made and low-water fall obtained. This opportunity was taken to locate permanent bench marks at the head and foot of all shoals and points likely to require improvement, at from 4 to 5 feet above water surface, so that at any future day should the survey be continued low-water plane could be readily established.

The low-water plane was very accurately determined from Chattanooga to Bridgeport, as well as the high-water slope. All levels of the survey were referred to the zero of the Chattanooga gauge, which is said to be 630.64 feet above mean tide, and is the lowest water ever known. Whenever practicable, levels were taken directly on the river bed without reference to water surface, but the latter was always noted.

The discharge of the river at a 3-foot stage was obtained at a cross section 1 mile below the Chattanooga gauge. The river was divided into sections of 50 feet, and a number of velocities taken in each section. The total area of cross section was 7,900 square feet, and mean velocity 2.19 feet per second, giving a discharge of 17,301 cubic feet. The discharge at a 30-foot stage was also determined at the same cross section; area of cross section, 40,336 square feet; mean velocity, 5.49 feet per second, giving a discharge of 221,444 cubic feet per second.

During the winter and spring tides of 1892 detailed observations were made of the action of the current at various stages from 5 to 38 feet, and surface velocities taken in the channel at all important points to determine at what points and stages navigation was the most difficult. From these observations the accompanying tables were prepared and will be of interest.

Maps of all portions needing improvement were drawn on a scale of 50 to 200 feet per inch, as the necessities were thought to require, with 5-foot contours to high water mark.

In the mountain section, the obstructions consist solely of conglomerate sandstone reefs and bowlders, and bars of rounded sand cobblestones brought down by mountain streams entering the river. An analysis of the stone showed as follows, and fairly represents all rock in this section:

Silica	93.699
Oxide of iron and alumina	5.739
Lime	0.298
Magnesia	0.264

At Ross Towhead, Bridgeport, Widow Bar, and Guntersville, the rock is limestone dipping either up or down stream with gravel between ledges.

As soon as possible after completion of the survey, a force was organized and the necessary appliances and plant secured for work in the channel at Tumbling Shoals. Three cribs, each 13 by 8.5 by 8 feet, were put in at the head to break the force of the water while excavating. Twenty-eight cubic yards of rock were removed from the channel, requiring 89 feet of holes to be drilled. The excavated material was placed in the cribs. High water stopped channel work, and the force was employed in removing bowlders and trees from the banks to high water.

On May 1 work was begun at Suck Point and consisted in widening the cross section by the removal of large bowlders and trees along the bank from low to high water mark.

The following work has been done during the year: Four snags removed from the channel at Tumbling Shoals; 1,181 trees cut from the left bank and 2,270 from the right bank between the head of Tumbling Shoals and foot of Suck Point; 342 trees cut from the left bank at the Suck. At Poor Horse Bar 758 cubic yards of rock blasted and removed; at Shoal Point 1,766 cubic yards of rock were removed. At Suck Point 5,559 cubic yards of rock were blasted and all excepting 1,339 cubic yards were removed. One thousand and eighty-five feet of holes were drilled in rock at the Suck, preparatory to blasting. All blasted rock was boated and dumped in the big eddies between the shoals.

Miscellaneous work consisted in the erection of derricks, platform for drilling, repairs of barges, quarter boat, skiffs, boating of coal, supplies, etc.

Statement showing in miles per hour the surface velocity of current in channel at different readings of gauge at the head of Tumbling Shoals, Tennessee River.

Gauge readings.	6.45.	9.65.	10.90.	12.40.	21.40.	38.	Remarks.
	Miles per hour.	*Miles per hour.*	*Miles per hour.*	*Miles per hour.*	*Miles per hour.*	*Miles per hour.*	
Tumbling Shoals	5.12	4.18	....	4.22	5.38	4.86	
Suck Point	5.21	5.55	5.75	6.32	6.62	7.17	
Suck	7.43	7.52	7.95	7.79	6.79	8.32	
Suck Shoals	5.03	....	....	....	....	....	Velocity of current decreases as river rises at Suck.
Richie Point	....	....	....	....	6.92	9.13	Current strong at high stages only.
Pot	6.32	7.17	....	8.02	8.84	10.25	
Skillet	6.92	6.15	....	4.82	4.73	4.94	

Statement showing difference (in feet) between high and low water at important points between Chattanooga, Tenn., and Bridgeport, Ala.

Locality.	Low-water fall.	1867, high-water fall.	1881, low-water elevation.	High-water elevation.	Difference.	Remarks.
Chattanooga	....	....	630.64	688.64	58	United States gauge.
Head of Ross Towhead	2	....	628.64	....	....	
Foot of Ross Towhead	3.84	1.73	626.80	686.91	60.11	
Chattanooga Creek	4.70	1.18	625.90	687.46	61.56	United States gauge. Bend at Lookout Mountain.
Browns Ferry	7.18	3.55	623.46	685.09	61.63	
Head of Williams Island	7.35	....	623.29	....	....	Above bar.
Jackson Bar	11.12	....	619.52	....	....	
Head of Tumbling Shoals	11.86	5.44	618.78	683.20	64.42	Bottoms disappear.
Foot of Tumbling Shoals	17.47	....	613.17	....	....	
Head of Suck Point	17.51	....	613.13	....	....	
Head of Suck	17.86	7.79	612.78	680.85	68.07	
Foot of Suck Wall	19.58	8.63	611.06	680.01	68.95	
Head of Suck Shoals	20.64	....	610	....	....	
Foot of Suck Shoals	22.23	....	608.41	....	....	
Richies, between Suck and Pot.	22.98	22.14	607.66	666.50	58.84	
Head of Skillet	24.12	24.13	606.52	664.51	57.99	
Foot of Skillet	28.74	....	603.90	....	....	Foot of fall.
Kelleys Ferry	29.21	31.41	601.43	657.23	55.80	
Shellmound	32.71	....	597.93	....	....	
Bridgeport	37.06	54.29	593.58	634.35	40.77	Left channel, railroad bridge.

REPORT OF MR. W. G. WILLIAMSON, ASSISTANT ENGINEER.

Summary of work done on Elk River Division of the Muscle Shoals Canal, from July 1, 1891, to June 30, 1892:

(*1*) *Above Lock A.*—The cross dam opposite Miltons Bluff was removed by the dredge; 1,352 cubic yards of loose rock were handled. Eight thousand two hundred and eighty-six cubic yards of mud and sand were dredged from the back of the dam behind the tow-heads just below Miltons Bluff, in order to build that portion of the dam which was incomplete. Seven hundred and twenty-two cubic yards of mud and sand and clay were dredged and removed with shovels from the cofferdam surrounding the drift sluice, and the sluice gate prepared for use. Three thousand five hundred and sixty-two and one-half cubic yards of stone were quarried at the Bluff quarry, 9¼ cubic yards of dimension stone, and 812 cubic yards of stripping done. Fourteen cubic yards of stone were cut for the lock masters' houses to be built at Locks A and B. Two hundred and twenty-seven and three-fourths cubic yards of masonry were built at the ends of the drift sluice. The sluice finished and put to use. Four thousand four hundred and six cubic yards of riprap dam were built above Lock A.

(*2*) *At Lock A.*—Forty-five cubic yards of earth were excavated for a drain to carry off the surface water. The foundation for the lock master's house was excavated. The house itself built complete, as per plans. There were 19.27 cubic yards of rubble masonry in the foundation.

(3) *Between Locks A and B.*—Ditches were dug to drain the sloughs on both sides of the canal. There were 1,635 cubic yards earth excavation in the ditches.

(4) *At Lock B.*—The foundation for the lock master's house at Lock B was excavated, and the masonry work, 19.27 cubic yards, built. The house itself was built complete, as per plans.

(5) *Below Lock B.*—In the channel below Lock B dredging was continued, with the assistance of an occasional blast when the rock proved of too solid a character to be handled by the dredge alone. Forty-five cubic yards of solid rock were taken from this channel, and 20,488 cubic yards of loose rock. This material was formed into a bank on the right of the channel, and at extreme low water is for a greater portion of the length of the cut exposed to view. Five hundred and forty six cubic yards of solid rock were blasted and removed from Nance Reef and placed on either side of the channel as guides for boats crossing the reef. The channel and its approaches are very much improved. Six buoys were anchored along the channel from Nance Reef to Gilchrist Chute, indicating the channel to be used by steamboats.

(6) *Miscellaneous.*—This work consisted in repairing the vessels and tools belonging to the plant; boating material, not only from point to point of the work, but also from Decatur to this division and the lower division; boating wood and coal, hauling supplies, sharpening tools for the quarry, repairing Engineer quarters, the kitchens and houses for the laborers, hauling wood and water to the quarters. The dredge *Harwood* and steam towboat *Elk* required frequent repairs, and were very often drawbacks to the prompt execution of work. The barges for boating material and the derrick boats all required occasional repairs and caulking.

The miscellaneous work consisted in general care of engineer property, repair of cars, locomotives, and tools, handling of wood and coal, hauling men to and from work, etc.

REPORT OF MR. W. A. M'FARLAND, ASSISTANT ENGINEER.

Summary of work on the Muscle Shoals Division from July, 1891, to June, 1892, both inclusive.

Above Lock 1.—The gap formerly existing through the wing dam near its shore end has been closed, 2,300 cubic yards of earth and 67 cubic yards of stone being used in the work.

Lockmaster's house at Lock 1.—This house was painted inside and out, and slight repairs were made to doors and windows. It is now completed and occupied. A masonry cistern having a capacity of 1,130 cubic feet was also built.

The lockmasters' houses built during the year are two-story frame buildings, having two rooms and an office on the first floor and three rooms on the second; they are supported on masonry wall and piers, containing 27 cubic yards, except Lock 9, where 32 cubic yards were used, have double floors, storm sheathing and siding, and are plastered throughout. They were built at the following-named locks:

At Lock 2.—House completed; cistern of 800 cubic feet capacity built.

At Lock 3.—House completed; cistern of 800 cubic feet capacity built.

At Lock 4.—House completed and occupied.

At Lock 5.—House completed; cistern of 800 cubic feet capacity built.

At Lock 6.—House completed and occupied.

At Lock 9.—House completed except interior finishing on lower floor and painting.

Houses for assistant lockmasters were built at Locks 3, 6, and 9; these are one-story buildings of three rooms; they are completed and occupied.

Railway construction.—Twenty-four thousand five hundred and seventy-five feet of track were laid, completing the line and making total length of track 75,075 feet. The best of old rails on hand were used on side of track farthest from the canal, a new 40-pound steel rail being used on the canal side. Oak hewed ties 7 feet by 7 inches by 8 inches were laid and the whole well ballasted with broken stone. Two thousand and seventy-two cubic yards of stone were crushed for ballast, and about an equal amount of quarry chips and natural broken stone were placed in the work. Short spur tracks to facilitate the handling of cars were put in at Locks 1, 2, 3, 4, 5 and 6.

Paving embankment of canal.—The work of quarrying and crushing stone at Lock 4 Quarry for the purpose of paving inner slopes of canal embankments was continued until the end of February, when the work was discontinued for lack of funds. Following is a summary of work done during the year:

	Cubic yards.
Stone quarried	9,063
Earth stripped from quarry	3,995
Stone crushed	7,787

This crushed stone was placed on the inner slopes of the canal embankments, covering a length of 7,500 yards (4.3 miles).

A house for the storage of engineer property was built at Lock 6; this is a two-story frame building, strongly built, supported on stone masonry piers containing about 20 cubic yards; is 40 feet by 22 feet on the ground plan, and has on the first floor an office and bed room; it is completed and occupied.

Bridges.—Blue Water Bridge was strengthened by placing in each of the 9 spans intermediate trestles consisting of two uprights with diagonal bracing.

The bridge across Shoal Creek, 26 spans, has been entirely rebuilt, the old 9-inch steel I beams and rod bracing being removed and replaced by simple 20-inch wrought iron I's; the old 9-inch steel I's were cut into suitable lengths for use as cross-bracing on the new bridge, and were riveted to the web of the 20-inch I's with angle plates and three-quarter-inch rivets. The new bridge is completed and in use.

The wooden cushions formerly used to support the ends of I beams of bridges at Second Creek, Helltown Branch, and Douglass Branch were replaced with stone.

Cross-bracing similar to that used on the new Shoal Creek Bridge, was put on bridges at Second Creek, Helltown Branch, Douglass Branch, Four Mile Creek, and Six Mile Creek.

Ditching.—Ditches having an average cross-sectional area of 12 square feet were dug outside of the canal embankment, for the purpose of intercepting leakage from the canal, at the following locations:

	Linear feet.
Above Lock 2	2,520
Between Locks 4 and 5	4,593
Between Locks 5 and 6	2,400
Opposite Lock 6	350
Between Locks 6 and 7	1,686
Total	11,549

COMMERCIAL STATISTICS.

Between Chattanooga, Tenn., and Decatur, Ala.

	Year ending June 30—			Year ending June 30—	
	1891.	1892.		1891.	1892.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Lumber	653	3,113	General merchandise	451	10,036
Cotton	580	3,038	Logs and wood	37,500	45,755
Live stock	2	621	Iron		2,250
Grain	1,166	7,396	Staves		5,272
Flour	61	1,054			
Cotton seed	93	285	Total	40,306	78,820

Between Florence, Ala., and Paducah, Ky.

	Year ending June 30—			Year ending June 30—	
	1891.	1892.		1891.	1892.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Iron	10,299	6,970	Flour	6,409	6,073
Staves	3,427	3,986	Cotton seed	1,194	995
Lumber	29,172	24,742	Sand	2,160	2,353
Cotton	5,029	6,105	General merchandise	28,993	36,114
Peanuts	4,294	4,649	Logs	297,789	71,336
Live stock	1,384	2,189	Railroad ties	30,000	46,749
Hoop poles	473	5,699			
Grain	14,843	18,249	Total	435,466	236,209

The statement of the commerce between Florence, Ala., and Paducah, Ky., shows an apparent decrease of 199,257 tons. This is due to fewer logs having been towed during the fiscal year ending June 30, 1892, than during that ending June 30, 1891.

There is an actual increase in staples of 27,196 tons.

List of steamboats (stern wheel) plying on the Tennessee River below Chattanooga, Tenn.

Name of boat.	Length.	Breadth	Depth.	Tonnage.
Between Chattanooga, Tenn., and Decatur, Ala.	*Feet.*	*Feet.*	*Feet.*	*Tons.*
Dixie	80	19	3.2	68.33
Maude			2.5	23.30
B. F. Young	120	24.3	4	160.86
R. C. Gunter	153	28	4	337.30
Wyeth City	120	21.5	4.8	138.96
J. R. Hughes	98	17	3.5	95.15
Pinhook	94	18	3	90.60
R. T. Coles	118	24.6	4.2	134.91
Herbert	134	27.8	3.6	167.60
Below Florence, Ala.				
City of Savannah	186	31	5	535.55
City of Sheffield	180	35	5.5	650
City of Paducah	183	37	5.25	700
W. F. Nesbitt	200	35	6.1	576.86
Clyde	181	32.5	5.6	382.96
A. T. Willis				133
Iron Age	226	34.4	16.8	967.57
Gus. Genin	120	20	4	130.09

CC 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal, which has been in the course of construction since 1875, was formally opened to public traffic on the 10th day of November, 1890.

The canal consists of two sections, the Elk River division and the Muscle Shoals division. The former is 1.5 miles long and has two locks, each 60 by 300 feet, with a total lift of 23 feet. The Muscle Shoals division, beginning about 8 miles below, is 14.5 miles long, and has been constructed by rebuilding and enlarging the old canal built by the State of Alabama, 1831–1836. This canal was used for one season, but the obstructions in the river above and below permitted navigation only during certain stages of the water. As no funds were appropriated for its maintenance, it was abandoned in 1837.

As reconstructed, this division contains nine locks of same dimensions as those in the upper division, with a total lift of 85 feet.

During the past fiscal year the canal has been maintained in working order, and the only delay to traffic was for about two hours in January, when the level below Lock 6 was necessarily emptied to permit the closing of several small leaks.

A complete patrol of the embankments was made daily for the purpose of detecting leaks, and these, when likely to be serious, were repaired at once.

A break 50 feet in length occurred at the west abutment of Sixmile Dam, extending down to rock, or a depth of about 15 feet; 994 cubic yards of earth and 142 cubic yards of rock and broken stone were used in its repair. A serious break occurred on April 21 on the north side of the canal, extending 75 feet from the east abutment of the aqueduct, and down to a depth of 20 feet below the top of the embankment. In repairing the breach, 2,300 cubic yards of broken stone, gravel, and earth were used, besides 130 cubic yards of heavy riprap placed on the outer slope near the toe.

A large number of small leaks on both divisions of the canal were stopped by the use of broken stone, gravel, and clay.

The valves for emptying and filling the locks have been very trouble-

some, and have required frequent repairs. At Lock 7 an old valve, having given out entirely, was replaced by a new lift valve with counterbalance and pawl-and-ratchet lifting gear, designed by Mr. W. A. McFarland, assistant engineer, which gives better satisfaction. Two cast iron balanced valves, working on vertical shafts, were put in at Lock 6, and work well, being easily handled by one man.

The amount of sediment removed from the canal by the dredges is as follows:

	Cubic yards.
Above Lock A (by dredge *Harwood*)	750
Above Lock 1 (by *Bucyrus* dredge	9,500
Below Lock 2 (by *Bucyrus* dredge)	60
Between Locks 3 and 4 (by *Bucyrus* dredge)	9,500
Between Locks 4 and 5 (by *Bucyrus* dredge)	7,650
Between Locks 5 and 6 (by *Bucyrus* dredge)	500
Total	27,960

The old cofferdam at Second Creek was also removed.

The heavy rains in April caused the water in the canal to rise 2 feet above Lock 2, and 200 cubic yards of filling were washed from behind the lower wing wall. This material was deposited immediately below the lock and had to be removed by hand.

Five thousand eight hundred and ten logs were removed from the canal above Lock A and five snags pulled; nearly all of this drift was turned into the river through the drift sluice. Two hundred and seventy-four logs were removed from the canal between Locks A and B. Weeds were cut from the towpath from Lock 1 to Lock 3, and from Lock 4 to Lock 9.

A locomotive has been used to tow barges through the canal, and it has been very useful in assisting tows and steamboats.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
Total	71,792.04

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation, indefinite, to be applied to current expenses in operating the Muscle Shoals Canal from July 1, 1892, to June 30, 1893.

Amount required for fiscal year ending June 30, 1893	$60,000.00
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities	14,767.10
Additional allotment required for fiscal year ending June 30, 1893	45,232.90

To be expended as follows:

1 assistant engineer, at $175 per month	2,100
1 master mechanic, at $100 per month	1,200
11 lockmasters, at $75 per month each	9,900
11 assistant lock masters, at $40 per month each	5,280
1 clerk, at $100 per month	1,200
1 engineer at machine shop, at $60 per month	720
1 telephone line man, at $50 per month	600
2 blacksmiths, at $75 per month each	1,800
1 carpenter, at $80 per month	960
2 overseers, at $80 per month each	1,920
30 laborers, at $30 per month each	10,800
Dredging and towboat crews, $800 per month	9,600
Subsistence, $450 per month	5,400
Repairs of dredge, plant, material, and contingencies	8,520
Total for one year	60,000

Statement of traffic through the Muscle Shoals Canal during the fiscal year ending June 30, 1892, compared with the traffic during the seven and two-thirds months of the fiscal year ending June 30, 1891, during which the canal was open to traffic.

	Year ending June 30— 1891.	1892.
Steamers .... number..	26	50
Barges .... do....	19	58
Rafts .... do....	7	11
Miscellaneous craft .... do....	....	13
Tonnage .... tons..	4,257	5,189
Lumber .... do....	645	730
Cotton .... do....	157	199
Grain .... do....	866	1,585
Flour .... do....	640	(*)
Oak extract .... do....	578	1,000
General merchandise .... do....	130	1,056
Logs .... do....	280	900
Iron .... do....	....	1,130
Coal .... do....	....	315
Total	3,296	6,915
Passengers .... number..	175	1,012

*Included in general merchandise.

The above statement is exclusive of supplies brought by United States steamers.

Detailed expenses incurred for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1892.

Month.	Office and administration. Salaries.	Supplies.	Total.	Operating, care, repairs, etc. Locks A and B. Labor.	Subsistence.	Supplies.	Total.	Locks 1 to 9. Labor.	Subsistence.	Supplies.	Total.	Grand total.
1891.												
July.	$175.00	.....	$175.00	$250.00	$53.86	$3.29	$307.15	$1,643.67	$195.47	....	$1,839.14	$2,321.29
Aug.	175.00	.....	175.00	567.92	61.17	......	629.09	1,729.00	212.68	....	1,941.68	2,745.77
Sept.	175.00	.....	175.00	534.13	67.63	6.86	608.62	1,619.00	190.42	....	1,809.42	2,593.04
Oct..	175.00	.....	175.00	200.00	50.14	38.75	288.89	1,680.00	199.70	$89.94	1,969.64	2,433.53
Nov.	175.00	.....	175.00	479.05	58.17	......	537.22	1,312.00	201.42	....	1,813.42	2,525.64
Dec..	175.00	.....	175.00	401.66	55.35	......	457.01	1,620.00	192.40	154.85	1,967.25	2,599.26
1892.												
Jan..	198.30	.....	198.30	386.33	54.96	......	441.29	1,940.00	250.52	1,690.66	3,881.18	4,520.77
Feb..	255.00	.....	255.00	558.33	70.75	......	629.08	2,570.16	263.02	471.67	3,304.85	4,188.93
Mar.	255.00	.....	255.00	380.00	52.61	......	432.61	2,561.50	260.79	333.25	3,155.54	3,843.15
Apr.	255.00	.....	255.00	380.00	51.50	......	431.50	2,897.52	185.99	156.67	3,240.18	3,926.68
May.	255.00	$9.25	264.25	330.00	53.10	......	383.10	2,599.80	224.68	425.90	3,250.38	3,897.73
June.	255.00	7.00	262.00	314.67	94.95	60.00	469.62	3,010.05	249.58	645.86	3,905.49	4,637.11
	2,523.30	16.25	2,539.55	4,782.09	724.19	108.90	5,615.18	25,482.70	2,626.67	3,968.80	32,078.17	40,232.90

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